The *ARRL*

$19.95

EMERGENCY COMMUNICATION HANDBOOK

Published by:

ARRL

The national association for

AMATEUR RADIO

Emergency Communication Handbook

Editor
Steve Ford, WB8IMY

Composition and Proofreading
Shelly Bloom, WB1ENT
Kathy Ford

Cover Design
Sue Fagan

ARRL *The national association for AMATEUR RADIO*
Newington, CT 06111-1494
ARRLWeb: www.arrl.org

ISBN: 0-87259-938-8

First Edition
Second Printing, 2006

Contents

Foreword

The mandate to serve the public has been at the core of Amateur Radio since its earliest days. And in the wake of the terrorist attacks on September 11, 2001, the need has been more keenly felt.

As hams, we have a unique ability to assist in times of trouble. We're experienced communicators. We know how to make radios work. We have the skill to efficiently communicate helpful and even life-saving information when other communication systems fail.

To provide emergency training to as many amateurs as possible, the ARRL created a series of Amateur Radio Emergency Communications Courses (ARECC). Some are conducted on-line and others are conducted in person throughout the nation. Thousands of amateurs have honed their emergency skills through these courses.

The *ARRL Emergency Communication Handbook* is distilled from the information presented in the courses. I hope you'll find it to be a valuable resource.

Of course, this book and the courses would not have been possible without the contributions of many amateurs. The acknowledgementso n the folloing page are by no means all of the contributors. We've gratefully received too many to name them all. Whether all or part of their material was used in the *ARRL Emergency Communication Handbook*, or if we simply used their material as review or reference in what was needed to be covered, we are sincerely grateful to each and every one for their dedication and willingness to participate.

73,
David Sumner, K1ZZ
ARRL Executive Vice President
Janaury 2005

Acknowledgments

ARECC Advisory Committee

L.B. Cebik, W4RNL
Dan Miller, K3UFG
Rick Palm, K1CE
Pat Lambert, WØIPL
Ron Hashiro, AH6RH
Gary Payne, N9VE
Greg Jones, K3GJ
David Doane, KC6YSO
Joe Dorn, W5VEX
Paul Cavnar, NN7B
Jack Riegel III, N5JAK
Lyle Meek, W6WF
Betsey Doane, K1EIC
Terry Dettman, WX7S
David Lane, KG4GIY
Harry Lewis, W7JWJ
Rich Slover, ND4F
Rob Foshay, W9VK
Eldon McDonald, KE4OCW
Taylor Davidson, N4TD
Jeff Stidham, KC7FUY
Richard Werner, K7UK
Ed Harris, KE4SKY
Randy Long, WØAVV
Dave Tuttle, NC4DT
Tuck Miller, NZ6T
Stan Kaplan, WB9RQR
Jim Cluett, W1PID
Jerry Boyd, K6BZ

ARECC Contributors

Patrick Taber, W5ABQ
Terry Busby, W5ARS
Art Feller, W4ART
Perry Lundquist, W6AUN
Randy Allen, KAØAZS
Paul Cavnar, NN7B
Kelly Bersch, KC7CSB
Mark Jewell, KC6CUB
Ben Green, WD8CZP
Margie Bourgoin, KB1DCO
Brian Fernandez, KE6HKJ
Tom McClain, N3HPR
Larry Dunn, N9HSW
Randall Winchester, WD4HVA
Mary Lau, N7IAL
Ken Akasofu, KL7JCQ
Mark Greene, PhD KD7JNF
Scott Garrett, W8JSG
Dave Waltrous, WD2K
John Hennessee, N1KB
Max Soucia, N1KQS
Fred Stone, W8LLY
Ray Moody, AH6LT
Suzy Price, N2LZR
Dave Patton, NT1N
Ruben Kafenbaum, WA2NBL
Jim Andrews, WAØNHD
Nick Leggett, N3NL
F. Dale Williams, K3PUR
Dennis Bodson, W4PWF
Bob Josuweit, WA3PZO
John Evans, N2QCE
Brennan Price, N4QX
Len Koppl, KDØRC
T.S. Bell, N2RSI
Ken Goetz, N2SQW
Rosalie White, K1STO
Paul Drothler, WO4U
Robert Lunsford, KB8UEY
Rich Werner K7UK
Peter Laws, N5UWY
Mike Manes, W5VSI
Jim Weslager, K3WR
Steve Ewald, WV1X
Ed Bixby, AKØX
David Doane KC6YSO
Dave Colter WA1ZCN

About the ARRL

The seed for Amateur Radio was planted in the 1890s, when Guglielmo Marconi began his experiments in wireless telegraphy. Soon he was joined by dozens, then hundreds, of others who were enthusiastic about sending and receiving messages through the air—some with a commercial interest, but others solely out of a love for this new communications medium. The United States government began licensing Amateur Radio operators in 1912.

By 1914, there were thousands of Amateur Radio operators—hams—in the United States. Hiram Percy Maxim, a leading Hartford, Connecticut inventor and industrialist, saw the need for an organization to band together this fledgling group of radio experimenters. In May 1914 he founded the American Radio Relay League (ARRL) to meet that need.

Today ARRL, with approximately 170,000 members, is the largest organization of radio amateurs in the United States. The ARRL is a not-for-profit organization that:

- promotes interest in Amateur Radio communications and experimentation
- represents US radio amateurs in legislative matters, and
- maintains fraternalism and a high standard of conduct among Amateur Radio operators.

At ARRL headquarters in the Hartford suburb of Newington, the staff helps serve the needs of members. ARRL is also International Secretariat for the International Amateur Radio Union, which is made up of similar societies in 150 countries around the world.

ARRL publishes the monthly journal *QST*, as well as newsletters and many publications covering all aspects of Amateur Radio. Its headquarters station, W1AW, transmits bulletins of interest to radio amateurs and Morse code practice sessions. The ARRL also coordinates an extensive field organization, which includes volunteers who provide technical information and other support services for radio amateurs as well as communications for public-service activities. In addition, ARRL represents US amateurs with the Federal Communications Commission and other government agencies in the US and abroad.

Membership in ARRL means much more than receiving *QST* each month. In addition to the services already described, ARRL offers membership services on a personal level, such as the ARRL Volunteer Examiner Coordinator Program and a QSL bureau.

Full ARRL membership (available only to licensed radio amateurs) gives you a voice in how the affairs of the organization are governed. ARRL policy is set by a Board of Directors (one from each of 15 Divisions). Each year, one-third of the ARRL Board of Directors stands for election by the full members they represent. The day-to-day operation of ARRL HQ is managed by an Executive Vice President and his staff.

No matter what aspect of Amateur Radio attracts you, ARRL membership is relevant and important. There would be no Amateur Radio as we know it today were it not for the ARRL. We would be happy to welcome you as a member! (An Amateur Radio license is not required for Associate Membership.) For more information about ARRL and answers to any questions you may have about Amateur Radio, write or call:

ARRL—The national association for Amateur Radio
225 Main Street
Newington CT 06111-1494
Voice: 860-594-0200
Fax: 860-594-0259
E-mail: **hq@arrl.org**
Internet: **www.arrl.org/**

Prospective new amateurs call (toll-free):
800-32-NEW HAM (800-326-3942)

You can also contact us via e-mail at
newham@arrl.org
or check out *ARRLWeb* at **www.arrl.org/**

CHAPTER ONE

Amateurs as Professionals —The Served Agency Relationship

"What does has my attitude have to do with emergency communications?" In a word, everything! It is even more important than your radio skills. Historically speaking, the attitude of some Amateur Radio volunteers has been our weakest point.

In situations where a professional and helpful attitude is maintained, served agencies point with pride to ham's efforts and accomplishments. The opposite situation is clearly illustrated in the words of one emergency management official who said, "Working with ham radio operators is like herding cats—get them the heck out of here!" This man was clearly frustrated with the attitude of his volunteers.

Although our name says that we are "amateurs," its real reference is to the fact that we are not paid for our efforts. It need not imply that our efforts or demeanor will be anything less than professional. "Professionalism" means getting the job done efficiently—with a minimum of fuss.

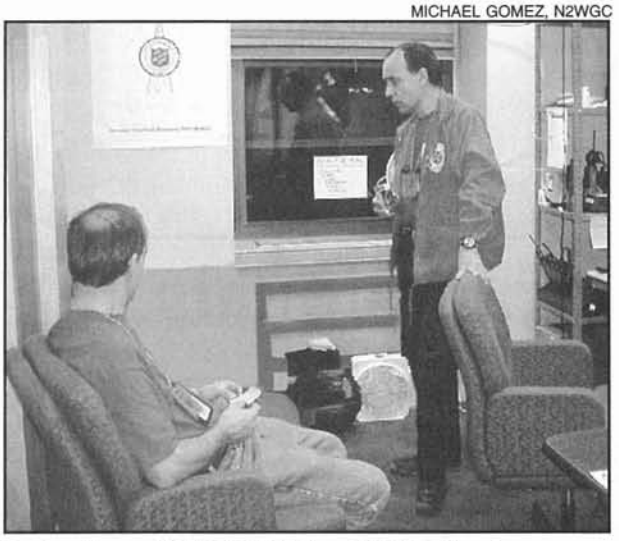
Your services at an emergency may not necessarily involve a radio!

No matter which agency you serve—emergency management, the Red Cross or others, it is helpful to remember that emcomm—emergency communication—volunteers are like unpaid employees. If you maintain the attitude that you are an employee of the agency you are serving, with all that employee status implies, there is little chance for you to go astray. You are there to help solve their communication problems. Do whatever you can, within reason, to accomplish that goal, and avoid becoming part of the problem.

Who Works For Whom

The relationship between the volunteer communicator and served agency will vary somewhat from situation to situation, but the fact is that *you work for them*. It doesn't matter whether you are part of a separate radio group like the

MICHAEL GOMEZ, N2WGC



Carlos Varon, K2LCV (right) and Jeff Schneller, N2PHO, at Salvation Army Headquarters in New York City in the days following the September 11, 2001 terrorist attacks.

Amateur Radio Emergency Service (ARES}, or part of the agency's regular volunteer force. *You* still work for *them*.

Your job is to meet the communication needs of the served agency. Period. It is not to show off your fancy equipment, nor to impress anyone with your knowledge of radio and electronics. A "know-it-all" or "I will show you how good I am, and how inadequate you are" attitude will end your—and our—relationship with the served agency in a hurry.

It is often said that volunteers don't have to take orders. This is true—we do not. However, when you volunteer your services to an organization, you implicitly agree to accept and comply with reasonable orders and requests from your "employer." If you do not feel comfortable doing this, do not volunteer.

There may be times that you find yourself unwilling or unable to comply with a served agency's demands. The reasons may be personal, or related to safety or health, or it may be that you do not consider yourself qualified or capable of meeting a particular demand. On rare occasions, it may be that they ask you to do something not permitted by FCC rules. Regardless of the reason, respectfully explain the situation and work with the served agency or your superiors in the communication group to come up with an alternative solution. If the discussion with the served agency becomes difficult or uncomfortable, you can always politely pass the discussion up to your immediate emcomm superiors so that they can handle it instead.

How Professional Emergency Responders Often View Volunteers

Unless a positive and long established relationship exists between professionals and volunteers, professionals who do not work regularly with competent volunteers are likely to look at them as "less than useful." There are several reasons for this. Fire departments have a long history of competitive relationships between professional and volunteer firefighters, and this attitude may carry over to volunteers in general. Police agencies are often distrustful of outsiders—often for legitimate information security concerns. Professionals in any field put a great deal of time and effort into their skills and training, and take considerable pride in their professional standing. As a result, they may view themselves as able to handle all possible situations without outside assistance.

Volunteers, on the other hand, are often viewed as "part timers" whose skill level and dedication to the job vary widely. Many agencies and organizations have learned that some volunteers cannot be depended on when they are needed most. Do not be offended if this attitude is obvious, and remember that you cannot change it overnight. It takes time for you to prove yourselves, and for a positive working relationship to develop and mature.

The middle of an on-going incident is not the time to try to change a "we do not need you" attitude. If your offer of assistance is refused, do not press the issue. The incident commander is busy with more pressing needs, and if he changes his mind about your offer, he will probably contact you. Remember: the served agency's authority should never be challenged. They are in charge, and you are not.

Performing Non-Communication Roles

It has been said many times that our job should be strictly limited to communication. But is this a hard and fast rule? When you work as a SKYWARN weather spotter, or collect and relay damage reports for the Red Cross, is this not going beyond your role as a communicator?

Well, yes and no. The old model of the emergency communicator was one where a written message would be generated by the served agency and handed to the radio operator. They would format and transmit the message to another station, whose operator would then write it out and deliver it to the addressee. In this role, hams were strictly communicators, and due to the radio technology of the times, it was

appropriate. Those days are gone forever.

In today's fast paced emergency responses, there is often no time for this sort of system. Events are happening too quickly, and the agency's communications must move at the same speed. The job description will more likely be "any function that also *includes* communication," as defined by the served agency. For this reason, emergency communication groups should engage in pre-planning with the served agency to ensure that these jobs are clearly defined, and any additional job-specific training required is obtained in advance.

In general, emcomm groups should be prepared to perform jobs for their served agency that include the need to communicate. Here are a few of the many possible job descriptions:

- Radio operator, using Amateur or served agency radio systems.
- Dispatcher, organizing the flow of personnel, vehicles and supplies.
- Resource coordinator, organizing the assignments of disaster relief volunteers.
- Field observer, watching and reporting weather or other conditions.
- Damage assessor, evaluating and reporting damage conditions.
- Van driver, moving people or supplies from location to location.
- Searcher, also providing communication for a search and rescue team.

To perform these jobs, you may need to complete task-specific training courses, and take part in exercises and drills in addition to those required for emergency communication even beyond traditional Amateur Radio. In the ever-changing world of emergency response, this flexibility will become increasingly important if we are to continue our contribution to public safety as Amateur Radio operators.

Note: **Some emcomm groups may still enforce a "communication only" policy, and in some agencies, the old model may still be appropriate. Discuss this with your Emergency Coordinator or similar emcomm manager to be sure.**

Specific Agency Relationships

The relationship between the volunteer communicator and the served agency can be quite different from agency to agency, and even between different offices of the same agency. While the ARRL and other national communication groups have existing "Memorandums of Understanding" (MOU), sometimes called a "Statement of Understanding" (SOU) or "Statement of Affiliation" (SOA), with many served agencies that define our general relationships, the actual working relationship is more precisely defined at the local level. Different people have different ideas and management styles. Agencies in one area can have different needs from others and these can affect the working relationship between the agency and its emcomm volunteers. Emcomm groups often have their own written agreements with the agency's local office.

Here are some examples of relationships:

Department of Homeland Security (DHS): In June 2003, ARRL and DHS signed a Statement of Affiliation, making ARES an affiliate member of DHS's Citizen's Corp community readiness program. The agreement provides for training and a accreditation of ARES members, raising public awareness of Amateur Radio's role in emergency communications, and coordination of shared activities.

Federal Emergency Management Agency (FEMA): In most cases Amateur Radio emcomm operators will have little direct contact with FEMA and other federal agencies, except within the Military Affiliate Radio System (MARS) and at the national level with ARRL.

American Red Cross chapters may have their own communication teams that include amateurs, or they may have a SOU with a local ARES group or radio club. Typical assignments include linking shelters and chapter houses, performing damage assessment, handling supply and personnel logistics and handling health and welfare messages.

The Salvation Army maintains its own internal Amateur Radio communication support group, known as the Salvation Army Team Emergency Radio Network (SATERN). In some areas, ARES or other groups provide local communication support. Assignments are similar to the Red Cross.

State and Local Emergency Management: Some state and local emergency management agencies include Radio Amateur Civil Emergency Service (RACES) teams as part of their own emergency communication plan. Others use "outside" groups such as the Amateur Radio Emergency Service (ARES). In a growing trend around the country, all ARES members are also RACES registered operators and vice versa. Communication assignments may be similar to the Red Cross and Salvation Army, but may also include government command and control, and

inter-agency communications.

SKYWARN is a self-contained program sponsored by the National Weather Service, and not all members are Amateur Radio operators. Many use other radio systems or telephone, fax or e-mail to send in weather observations. SKYWARN volunteers collect on the spot weather observations that will allow forecasters to create forecasts that are more accurate, and issue timely warnings.

Talking to The Press

In any emergency situation, the press will be hunting for any tidbit of information they can get, and they may not care where they get it. One place they should *never* get information regarding the served agency or its efforts is from *you*. Politely refer all such inquiries to the served agency's public spokesperson. If you offer such information "just to be helpful," because you enjoy being in the spotlight, or to get some publicity for yourself or your emcomm group, the served agency would be well within its rights to ask you to leave.

Some emcomm organizations also have their own spokesperson. In ARES, this person is called the "Public Information Officer" (PIO)—other organizations may use a different job title. Their job is to handle press inquiries so that radio operators can do their jobs without interruption. In most all cases, they would only answer questions about the Amateur Radio group's efforts, and not those of the served agency.

If a reporter just will not leave you alone, you might feel obliged to say something so they will go away. In this case, the only thing you should discuss is your part of the emergency communication effort, but only if you are part of a separate emcomm group such as ARES, and *only if that organization's policy permits it*. If they are impeding your ability to do your job, briefly explain this to the reporter and politely but firmly direct them to the PIO or an emcomm management person.

Regardless of the situation, it is always a good policy to know in advance how your organization or served agency would like you to deal with press inquiries. If your emcomm organization does not have a press policy, you might suggest that one be developed. This will help prevent misunderstandings and hard feelings later.

Volunteering Where You Are Not Known

In some cases, an emergency occurs in a neighboring area where you are not a member of the responding communication group. For whatever reason, you might feel obligated to offer your services. If at all feasible, it is best to make your offer before making any significant preparations, or leaving home.

It is possible that your offer might be welcomed, but it is equally possible that it will be refused. There are good reasons for this, particularly where the served agency has specific requirements, such as specialized training, official IDs and time-consuming background checks. Most emcomm managers prefer to work only with operators whose abilities and limitations they know. They may also have more volunteers than they need, or may feel that your skills or equipment are not suited to their mission. If you are turned away, please accept the situation gracefully.

On the other hand, if your offer of assistance is accepted, the situation you find may vary quite a bit. In a well-organized effort, there will be someone to help orient you to the response effort, provide any required information and answer your questions. Your assignment will be clear, a relief person will be sent along at the end of a predefined shift, and you will know of any arrangements for food, sanitation and sleep.

If the effort is not well organized, little, if any, of the above scenario could be true. You might be given an assignment, but with little additional information or support. In this case, you will need to improvise and fend for yourself, and you should be prepared to do so. This is one good reason for making your offer of assistance in advance. Learn as much as you can about the response before preparing to leave home.

In any event, the best time to offer your services to an emcomm group is well before any emergency occurs. This will allow you to obtain the proper training and credentials, and to become known to the group's managers. When the time comes to serve, you will be ready for your job, and a job will be ready for you.

Worker's Compensation Coverage and Legal Protections

In some states, Worker's Compensation insurance coverage can be extended to volunteers working on behalf of a government or non-profit agency. However, Worker's Compensation law is a rather complex matter regulated by individual state's

laws. In many cases, it may not be possible for volunteers who are not also paid employees of a served agency to be covered by Worker's Compensation. Emcomm managers should investigate their state's laws on this subject rather than assume that the agency's Worker's Compensation coverage will automatically apply.

Volunteers providing services to government agencies or Section 501(c)(3) tax-exempt private organizations are provided immunity from liability by Federal law through the Volunteer Protection Act of 1997, 42 U.S.C. Section 14501. This generally limits liability if the volunteer was acting at the time within the scope of official duties under a volunteer program. There are exceptions: the law does not cover volunteers who cause harm while operating motor vehicles, or if the volunteer is grossly negligent, or engages in criminal acts. The statute, however, provides broad liability protection for amateurs in most contexts, and especially where amateurs volunteer under ARES to provide emergency communications to served agencies.

CHAPTER TWO

Network Theory and the Design of Emergency Communication Systems

The study of information transfer between multiple points is known as "network theory." During an emergency, messages vary greatly in terms of length, content, complexity and other characteristics. Similarly, the available communication pathways vary in how well they handle messages having different characteristics. Network theory can be thought of as the process of matching a particular message to the best communication pathway. The best pathway is that which can transfer the information with the most efficiency, tying up the communication resources the least amount of time, and getting the information transferred most accurately and dependably.

Hams are often invited to participate in emergency services planning, providing communications expertise. By incorporating some fundamental concepts about network theory into the planning of emergency communication systems, we can take advance steps to be sure that efficient and appropriate communication modes are available when the emergency strikes, thus providing a more valuable service to the public.

Let's start our discussion with the characteristics of messages.

Single versus Multiple Destinations

There are major differences between broadcasting and one-to-one (exclusive) communication channels. Some messages are for one single addressee while others need to be received by multiple locations simultaneously. And some messages addressed to one destination can be useful and informative to "incidental" listeners, like the National Weather Service. A specific instruction to a particular shelter manager is a completely different kind of communication than an announcement to all shelters. Yet, it is common to hear these messages on the same communications channel.

High Precision versus Low Precision

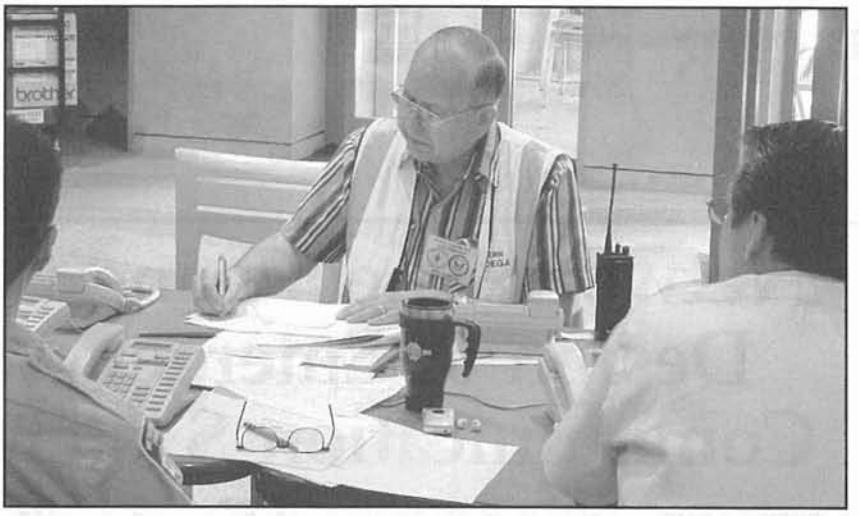
Precision is not the same as accuracy. All messages must be received accurately. But sending a list of names or numbers requires *precision* at the "character" level, while a report that "the lost hiker has been found" does not. Both may be important messages and must be transferred accurately. But one involves a need for more *precision*.

Over low-precision communications channels (such as voice modes) even letters of the alphabet can be misinterpreted unless a phonetic system, feedback or error-correcting mechanism is used. Conversely, typing out a low precision message that "the delivery van containing the coffee has arrived at this location" on a high-precision packet link can be more time consuming (and inefficient) than a simple voice report.

Complexity

A doctor at a hospital may use a radio to instruct

KL7IPV



Vern Garman, KØEGA, during an emergency communication exercise.

an untrained field volunteer how to splint a fractured leg. A shelter manager may report that he is out of water. The level of complexity varies greatly between these two messages.

Some messages are so long and complicated that the recipient cannot remember or comprehend the entire message upon its arrival. Detailed maps, long lists, complicated directions and diagrams are best put in hard copy or electronic storage for later reference. This avoids the need to repeat and ask for "fills," activities that tie up the communication channel. Some modes, such as fax and packet radio, by their very nature generate such reference copy. Others (such as voice modes) do not, and require a time-consuming conversion step.

Timeliness

Some messages are extremely time-critical, while others can tolerate delays between origination and delivery without adverse effect. Relief workers and their communicators can be very busy people. Requiring a relief worker to handle a non-time-critical message may prevent them from handling a more pressing emergency. Also, a message might need to be passed at a time when the receiving station is tied up with other business, and by the time the receiving station is free the sending station is then occupied. In these cases, provision can be made for "time shifting"—the message can be left at a drop point for pickup when the receiving station becomes free. Conversely, highly time-critical messages *must get through* without delay.

Timeliness also relates to the *establishment* of a communications link. Some modes, such as telephones, require dialing and ringing to establish a connection. An operator of a base station radio may need to track down a key official at the site to deliver a message. What matters is the total elapsed time from the time the message originates to the time it is delivered to its final party.

Priority

The concept of priority as used by Network Theory is better known to hams as QSK, the ability to "break in" on a communication in progress. For example, a communication pathway is in use with a lengthy, but low-priority, message. A need suddenly arises for a high-priority message. Can the high-priority message take precedence and interrupt the low priority one to gain access to the channel? Some communications modes allow for this; others do not.

Characteristics of Communication Channels

Now that we have looked at the different message characteristics, let's consider the communication channels that might be used in an emergency. In addition to the concepts of destination, precision, complexity, timeliness, and priority, communication channels also can be evaluated in terms of their reliability and ease of use.

Telephones

The pathway most familiar to non-hams is the telephone. This voice-based mode is surprisingly reliable, and can be operated without the need for specialized communication volunteers. It is often fully operational with plenty of unused capacity during localized and small-scale emergencies, but can quickly become overloaded during large-scale disasters.

The telephone system is very good for transferring simple information requiring low precision. Since this mode utilizes the human voice, transferring a large amount of high-precision data (such as spelling a long list of names or numbers) can become tedious and time consuming.

The telephone system is a one-to-one communication pathway, meaning it cannot be used for broadcasting. But, the one-to-one relationship between sender and receiver makes it ideal for messages containing sensitive or confidential information, such as casualty lists.

The exclusive nature of most telephone circuits makes it difficult or impossible to break-in on a conversation to deliver a higher-priority message. The need for break-in usually precludes leaving the channel open continuously between two points, resulting in the need to dial and answer each time a message needs to be sent.

The major drawback to telephones during emergencies is that the sending and receiving stations are not self-contained. The system requires wires and cables that can be damaged or destroyed during severe weather. When the central switching center goes down or becomes overloaded, all communications on this mode come to a halt, regardless of priority or criticality.

Cellular Phones

Cellular phones offer advantages that make them attractive: they are simple to operate and do not require a separate, licensed communication volunteer. They are lightweight and can be carried in a pocket, eliminating the need for tracking individuals as they move around.

Like landlines (and unlike devices used in Amateur Radio), cellular phones are ideally suited to one-to-one communications, avoiding distraction to stations not involved in the message exchange. They are unsuitable for multiple-recipient messages that are better handled on a broadcast-capable communications mode.

Like the landline telephone system, cellular phones are not self-contained communications units. They are reliant on a complex central switching and control system that is subject to failure or overloading. If the central base station goes down, or if its links with the other components of the phone system fail, cellular phone communication comes to a halt. There is no "go to simplex" contingency option with cellular phones.

Fax

Fax machines overcome the limitations of voice communications when it comes to dealing with high-precision, lengthy and complex information. A four-page list of first-aid supplies, for example, can be faxed much faster than it can be read over a voice channel and transcribed. Fax machines can transfer drawings, pictures, diagrams and maps—information that is practically impossible to transfer over voice channels.

A typical fax machine.

Today, fax machines are widely available. Most organizations use them as a routine part of their business communications. It is becoming increasingly likely that a fax machine will be found at the school, church, hospital, government center, or other institution involved in emergency or disaster-relief efforts. Most of today's computers (even laptops!) are equipped with modems that can send and receive fax information.

Another advantage of fax machines is their production of a permanent record of the message as part of the transfer process. They also facilitate "time-shifting." But they rely on the phone system, and add one more piece of technology and opportunity for failure. Except for laptop modems, they generally require 120Vac current, which is not always available during emergencies unless plans have been made for it.

Two-Way Voice Radio

Whether on the public service bands or ham frequencies, whether SSB or FM, via repeater or simplex, voice radio is simple and easy to operate. Most units can operate on multiple frequencies, making it a simple matter to increase the number of available communication circuits as the need arises. Most important, the units are generally self-contained, enhancing portability and increasing reliability of the

system in adverse environmental conditions.

Radios are ideal for broadcasting. On the flip side, though, while a message is being transferred between two stations, the entire channel is occupied, preventing other stations from communicating. Using radio for one-to-one communication can be very distracting to stations not involved in the exchange. (The most common example of inefficient use of communication resources is a lengthy exchange between two stations on a channel being shared by a large number of users.) Also, radios suffer from the low precision inherent in voice modes of communication.

Trunked Radio Systems

These systems are becoming highly popular with public service agencies. They are similar to the standard voice radio systems described above with two exceptions. Unfortunately, both exceptions have a direct (and adverse) impact on the use of trunked systems in emergency and disaster situations.

The first has to do with the fundamental purpose behind trunking. Trunked systems came into being to allow increased message density on fewer circuits. In other words, more stations could share fewer frequencies, with each frequency being utilized at a higher rate. Under everyday circumstances, this results in more efficient spectrum use. But when an emergency strikes and communication needs skyrocket, the channels quickly become saturated. A priority queue results, and messages are delayed. Medium and low priority messages, and even some high-priority messages, might not get through unless important stations are assigned a higher priority in the system's programming.

The second difference deals with the way that frequencies are shared. Trunked systems rely on a complex central signaling system to dynamically handle the mobile frequency assignments. When the central control unit goes down for any reason, the entire system — base and mobile units — must revert to a pre-determined simplex or repeater-based arrangement. This fallback strategy is risky in emergencies because of the small number of frequencies available to the system.

Packet Radio

As already mentioned, voice modes are ideal for low-precision messages. Digital data modes, on the other hand, facilitate high-precision message transfer. Modes such as packet radio ensure near-perfect accuracy in transmission and reception. And like fax machines, packet has the ability to provide a relatively permanent record of the message for later reference.

The packet mode has another advantage when dealing with information that is in electronic form: there is no need for a conversion step before transmission. This is especially valuable when the information being sent is generated by machine (such as automated weather sensors, GPS receivers, or shelter management computers).

Packet stations are generally self-contained, and if located within line-of-sight, do not need a central switching system.

Unlike fax machines, packet radio systems are perfect for the distribution of high-precision information to a large number of destinations simultaneously. And the automated retry feature means that several connections can share a single frequency simultaneously, effectively increasing the capacity of the channel.

Among its disadvantages, real-time packet messages require the operator to use a keyboard. This makes the mode unacceptable for low-precision but lengthy messages, such as describing an injury or giving a status report, especially where the operator is not a fast typist. Due to its need for perfect transmission accuracy, it may not be reliable along marginal RF paths. And unlike fax machines, most of today's common packet protocols are inefficient when transferring precision graphics, drawings and all but the most rudimentary maps.

Store-and-Forward Systems

Sometimes considered a subset of packet radio, store-and-forward systems (bulletin boards, messaging gateways, electronic mailboxes, etc) can handle non-time-critical messages and reference material, enabling communication in situations where sender and receiver cannot be available simultaneously. These systems also increase the effective capacity of a communication channel by serving as a buffer. When a destination is overloaded with incoming messages, the store-and-forward unit can hold the messages until the receiver is free.

It is important to remember that store-and-forward systems are not limited to digital modes. Voice-answering machines, and even an NTS-like arrangement of liaison stations can function as voice-based store-and-forward systems.

Other Modes

Slow-scan television, fast-scan television, satellite communications, human couriers, the Internet, e-mail and other modes of communication all have their own characteristics. Space limitations prohibit more discussion, but by now you get the idea of how communications channels relate to different types of messages.

Planning and Preparation—The Keys to Success

Serious communication planners should give advance thought to the kinds of information that might need to be passed during each kind of emergency they wish to consider. Will maps need to be transferred? What about long lists of names, addresses, supplies or other detailed identification? Will the communications consist mostly of short status reports? Will the situation likely require transfer of detailed instructions, directions or descriptions? Will they originally be in verbal, written or electronic form?

Planners should next consider the origins and destinations of the messages. Will one station be disseminating information to multiple remote sites? Will there be many one-to-one messages? Will one station be overloaded while others sit idle? Will a store-and-forward system, even via voice, be useful or necessary?

The content of the messages should also be considered. Will a lot of confidential or sensitive information be passed? Will there be a need for break-in or interruption for pressing traffic or can one station utilize (tie up) the communications link for a while with no adverse consequences?

Along with the message analysis described above, the frequency of occurrence (count of messages) of each type should also be estimated.

Then, in the most important step, the characteristics of the high-volume messages should be matched to one or more appropriate communication pathways.

Once you have identified the ideal pathways for the most common messages, the next step is to take action to increase the likelihood that the needed modes will be available during the emergency. Hams take pride in their "jump kit" emergency packs containing their 2-meter radios, extra batteries and roll-up antennas. How about doing the same thing for some additional communication modes, too? Put a list of critical phone numbers (including fax numbers, pager numbers, cellular numbers) in your kit. Make sure your local packet digipeater has battery backup. If you are likely to be assigned to a school, church, or office building, see if you can get a copy of the instructions for using the fax machine to keep in your kit. If the phones are out, know how to interface the fax machine to your radio.

Advance scouting may be needed. It is a good idea to see if fax machines are in place and whether they will be accessible in an emergency. Is there a supply of paper available? Are the packet digipeaters within range of every likely communication post? Can computers be made available or will hams have to provide their own? How will backup power be provided to the computers? Can a frequency list be developed, along with guidelines of when and how to use each frequency?

Contingency planning is also of critical importance. How many times has a repeater gone down, and only then did the communicators wish they had agreed in advance on an alternate simplex frequency? What will you do if you need to send a map and the fax machine power fails? Suppose you are relying on cellular phones and the cellular network fails? **Remember, if you plan for problems, they cease to be problems and become merely a part of the plan**.

The final step is training. Your manning roster, assignment lists, and contingency plans need to be tied in to the training and proficiency of your volunteers. Questions you might want to ask are: Who knows how to use a cellular phone? Who knows how to use fax software? Who knows how to upload or download a file from a packet BBS? Who knows how to touch-type?

By matching your needs with your personnel, you can identify areas where training is needed. Club meeting programs and field trips provide excellent opportunities for training, as well as building enthusiasm and sharing knowledge of the plans. You will be surprised at how a little advance planning and effort can go a long way to turning a volunteer mobilization into a versatile, effective, professional-quality communication system.

CHAPTER THREE

Emergency Communication Organizations and Systems

Imagine a random group of volunteers trying to tackle a full-scale disaster communication emergency, working together for the first time. They do not know each other well, have very different approaches to solving the same problem, and half of them want to be in charge. Get the picture?

It is not too far fetched. Just ask anyone who has been around emcomm for a while—they have seen it! This book is intended to help solve that problem, but without emcomm organizations, this book would be worthless.

Emcomm organizations provide training, and a forum to share ideas and develop workable solutions to problems in advance of a real disaster. This way, when the time comes to assist the served agency, you will be as prepared as you can be. The response will occur more smoothly, challenges will be dealt with productively and the served agency's needs met.

Some of the organizations discussed here do not directly involve Amateur Radio operators, but knowing about them and how they might assist in an emergency may be helpful. Your served agency may utilize or interact with one or more of these systems or organizations.

Amateur Radio Emergency Service (ARES)

Among the largest and oldest emcomm groups is ARES, a program sponsored by the American Radio Relay League (ARRL) since 1935. ARES is part of the League's field organization, which is composed of "Sections." Most Sections are entire states, but some larger states have two or more Sections.

The elected Section Manager (SM) appoints the ARES leadership. The top ARES leader in each Section is the Section Emergency Coordinator (SEC).

Some larger Sections, like Wisconsin, Michigan and Florida, are further divided into two or more Districts. In this case, each District is guided by a District Emergency Coordinator (DEC), working directly under the SEC. See **Figure 3-1**.

The next subdivision within ARES is the "county" or similar region assigned to an Emergency Coordinator (EC). Most ECs will have one or more Assistant Emergency Coordinators (AEC), who may have responsibility for specific tasks or cities. A large city with complex needs may have its own EC, but most towns and smaller cities will have an AEC.

ARES has Memoranda of Understanding (MOUs) with a variety of agencies at the national level, including the Federal Emergency Management Agency (FEMA), American Red Cross, Salvation Army and

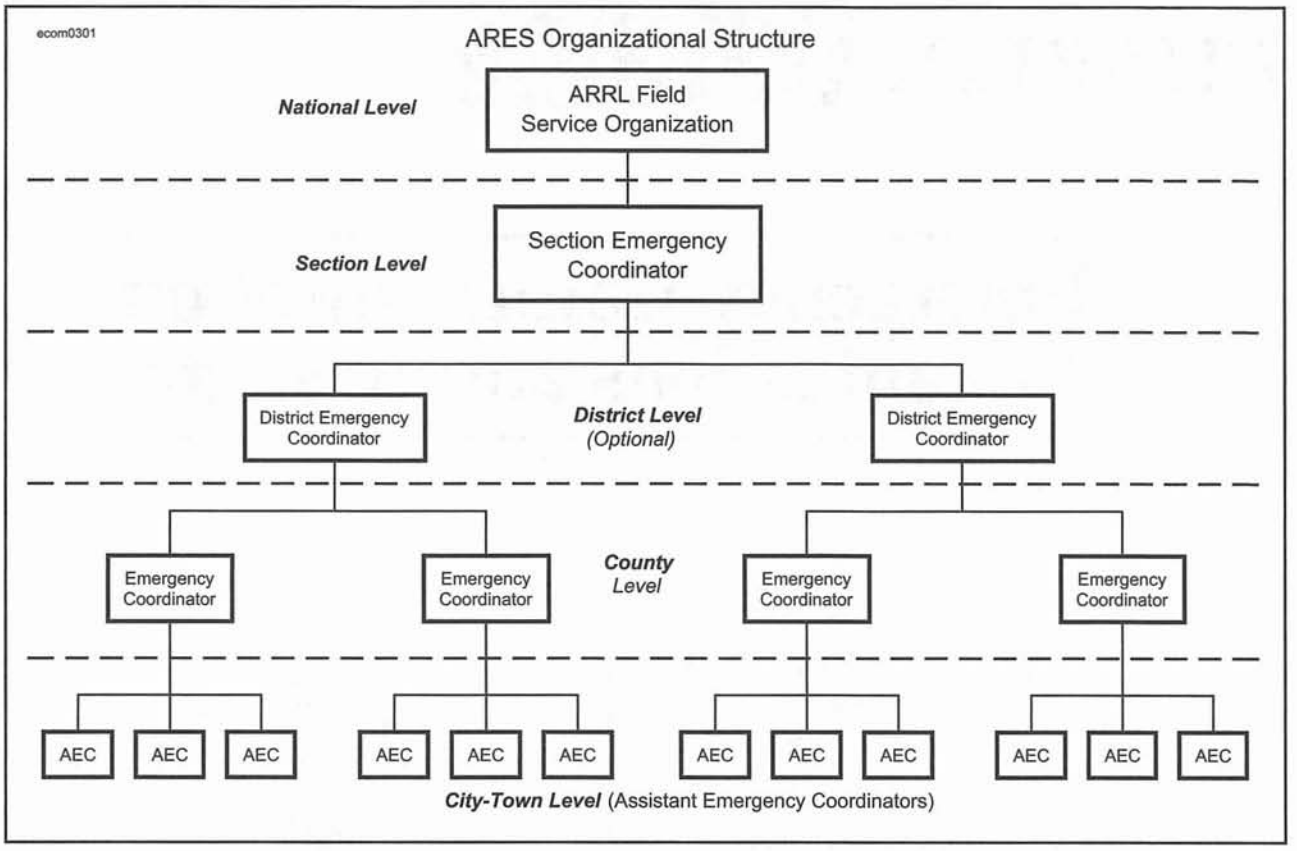


Figure 3-1—ARES organizational structure.

the National Weather Service. These documents set out the general relationship between ARES and the agency at the national level, and provide guidance for local units of both organizations to draft more specific local MOUs.

In addition to local chapters of national groups, ARES groups often have MOUs or other written or verbal agreements with state and city emergency management departments, hospitals, schools, police and fire departments, public works agencies, and others.

Radio Amateur Civil Emergency Service (RACES)

The federal government created RACES after World War II. The RACES rules addressed the need for Amateur Radio operators to function as an integral part of a state, county or local Civil Defense (CD) agency in time of national emergency or war. The RACES authorization provides the means to continue to serve the public even if the President of the FCC suspends regular amateur operations. In this situation, the RACES rules provide for use of almost all regular amateur frequencies, but place strict limits on the types of communications made, and with whom.

At one time, Civil Defense agencies could obtain a "RACES station license" that would allow non-ham agency personnel to use amateur frequencies under limited conditions. These licenses are no longer issued, but existing licenses can continue to be renewed. Also, operators of any RACES stations must now be licensed amateurs, and must follow the RACES rules at all times.

Over the years, both "Civil Defense" (now known as "Emergency Management" in most states) and the way it utilizes Amateur Radio operators have changed dramatically. There are fewer "pure" RACES operators today. Increasingly, RACES-registered operators also belong to ARES, and can switch hats when the need arises. Emergency management officials like this arrangement since it provides more flexibility, and gives them more direct control over their ham radio volunteers.

Salvation Army Team Emergency Radio Network (SATERN)

SATERN members are also Salvation Army volunteers. Their HF networks are used for both

logistical communication between various Salvation Army offices and for health and welfare messages. At the local level, ARES, REACT and other groups often help support the Salvation Army's operations.

The Rapid Response Team (RRT)

In the first minutes of an emergency, it is sometimes important to get the basic essentials of a network on the air quickly. The solution is the RRT concept, although its name may vary. In Hawaii, it is known as a Quick Response Team (QRT), and in New Hampshire, a Rapid Emergency Deployment Team (RED Team). Rather than a stand-alone organization, a RRT is small team within a larger emcomm group. Their job is to put a few strategically placed stations on the air within the first half-hour to an hour. These stations will usually include the emergency operations center (EOC), a resource net NCS, and often a few field teams where needed most. This is commonly known as a "Level 1 RRT response."

A Level 2 RRT response follows within a few hours, bringing additional resources and operators. Level 1 teams have pre-assigned jobs, and short-term (12-24 hour) jump kits, ready to go whenever the call comes. Level 2 teams have longer term (72 hour) jump kits, and a variety of other equipment, possibly including tents, portable repeaters, extended food and water supplies, sleeping gear, spare radios, and generators, depending on local needs.

ARES Mutual Assistance Team (ARESMAT)

When a communication emergency lasts longer than a day or two, or when the scale of the emergency is beyond the ability of a local ARES group to handle, help can be requested from neighboring areas. The ARESMAT concept was created to meet that need. These teams consist of hams who are willing and able to travel to another area for a period to assist ARES groups based in the disaster area. They may also bring additional resources in the form of radios, antennas and other critical equipment. If you travel to another area as part of an ARESMAT, remember that the local group is still in charge—you are there to do what they need done. In a sense, the host ARES group becomes a "served agency."

Military Affiliate Radio Service (MARS)

MARS is a Department of Defense sponsored auxiliary communication program, established as three separately managed and operated programs by the United States Army, Navy/Marine Corp, and Air Force.

The program enlists the services of licensed hams who operate disciplined and structured nets on assigned military radio frequencies adjacent to the amateur bands. MARS has a strict set of rules regarding the type, content and format of messages. Special call signs are issued for MARS use.

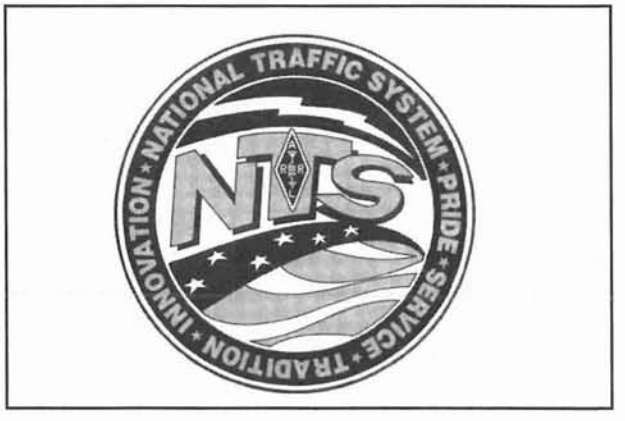
In day-to-day service, MARS stations handle quasi-official and morale messages for the three services. During times of emergency, MARS provides backup communication networks to military, federal, state and local agencies. MARS' most visible mission, providing phone patches to family members for US military personnel overseas, has diminished with the advent of new satellites that provide e-mail and phone service almost anywhere. However, this has never been MARS largest or most important function.

One advantage of the MARS system is that it is specifically authorized to communicate with other government radio services in time of emergency, including the federal SHARES HF networks.

National Traffic System (NTS)

Long before e-mail and the Internet, there was ARRL's NTS. The concept on which NTS is based is as old as ARRL itself. The NTS consists of local, regional and national nets operating on a regular basis to pass messages (traffic) from place to place. In day-to-day usage, the NTS handles non-critical organizational messages for its own members and ARRL field organizations, radiograms for the public, and various personal messages.

Since e-mail has become popular, the NTS has seen a significant decrease in the number of mes-



sages passed through the system, and a corresponding decrease in membership and overall effectiveness. However, NTS still has an important role in emergency communication, and discussions about modernizing the NTS are underway. A more in depth discussion of NTS will follow later.

Local Radio Clubs

Not every area has a working ARES or other nationally affiliated emcomm group. In many cases, the void is filled by local radio clubs who either work informally with served agencies, or with a formal MOU.

National Communications System (NCS)

A Federal agency, the NCS consists of 23 government organizations tasked with ensuring that the Federal Government has the necessary communication capabilities under all conditions from day-to-day use to national emergencies and international crises. These include the Forest Service, Federal Emergency Management Agency, Coast Guard, FBI, ATF and others who have a variety of communication assets. The Manager of the NCS is also the Director of the Defense Information Systems Agency (DISA), usually an Air Force general.

SHARES

Even those who have been involved with emcomm for years may not know of the US Government's "Shared Resources System," known as "SHARES." This system is part of the NCS. It pairs certain MARS operators with various federal agencies and state emergency operations centers to provide a high frequency (HF) communication backbone if normal communication systems should fail. In addition to government agencies, key communications companies such as AT&T, and agencies such as the Red Cross have SHARES radios. The SHARES system utilizes a number of nationwide and regional networks.

Federal Emergency Management Agency—FEMA National Radio System (FNARS)

This is a FEMA high frequency (HF) radio network designed to provide a minimum essential emergency communication capability among federal agencies, state, local commonwealth, and territorial governments in times of national, natural and civil emergencies. FEMA monitors the FNARS HF frequencies on a daily basis. At the state level, FNARS radios are typically located at the state's emergency operations center (EOC).

Radio Emergency Associated Communications Teams (REACT)

REACT is another national emcomm group, whose members include Citizen's Band (CB) radio operators, hams and others. In addition to CB and Amateur Radio, they may use General Mobile Radio Service (GMRS), Family Radio and the Multiple Use Radio Service (MURS).

REACT has an organizational structure similar to ARRL/ARES, with local teams who directly serve many of the same agencies served by ARES and other ham radio emcomm groups. REACT has MOUs with many of these agencies, as well as with ARRL.

REACT's mission is somewhat broader than that of ARES. They offer crowd and traffic control, logistics, public education, and other services that usually (but not always) include a need for radio communication.

Emergency Warning Systems

Emergency Alert System—EAS—(Broadcast Radio & TV): The current EAS system has evolved from the earlier Emergency Broadcast System (EBS) and the original CONELRAD system developed during World War II. The EAS relies on radio and TV broadcast stations to relay emergency alert messages from federal, state and local authorities. Messages may pertain to any immediate threat to public safety, including enemy attack, storm warnings, earthquake alerts and wildfires. Messages are relayed from station to station using automatic switching systems and digital signaling. You may have heard the required weekly EAS tests performed by radio and TV stations and their distinctive digital "squawk" sound.

NOAA Weather Alert and National Weather Radio (NWR): The National Weather Service (NWS) division of the National Oceanic and Atmospheric Administration (NOAA) operates NWR.

NWR uses seven frequencies in the 162 MHz band to carry audio broadcasts to the public. Forecast and warning information originates from the regional network of forecasting offices, and yields timely and quality alerts dealing with weather and other natural events.

Newer "weather alert" radios are available from a variety of manufacturers with the digital Spe-

cific Area Message Encoding (SAME) alert mechanism. SAME equipped radios will remain silent until an alert is received for a specific geographic area. The user programs one or more five-digit FIPS codes for the areas they wish to monitor. When the NWS broadcasts the alert with the SAME code matching that programmed into the receiver, the receiver will activate and allow you to hear the audio message concerning the alert. Some receivers also provide a textual display of the alert information. The NWS tests the SAME network at least once weekly, and the radio will indicate that it has heard the test alert within the past week.

NAWAS (National Warning System): The federal government maintains a "hardened" and secure national wireline phone network connecting the warning points in each state (usually the state police HQ or state EOC). The center of NAWAS operations is the National Warning Center at NORAD's Cheyenne Mountain command and control complex in Colorado. Its primary purpose is to provide notification in case of enemy attack, and to inform and coordinate alert and warning information among states in a given region. During peacetime, it carries alerts on a variety of wide-ranging emergencies. Roll call check-ins are taken periodically during the day to ensure that the phone circuits are functioning properly.

Statewide Warning Systems: These systems are similar to NAWAS, but at a state level. For most states that have such a system, county warning points are part of a statewide alert and warning network. It is known by different names in each state. For example, in Hawaii, it is HAWAS (Hawaii Warning System). In California, it is CALWAS.

In Hawaii, HAWAS connects the warning points in each island county, the Pacific Tsunami Warning Center, the local National Weather Service Forecast Office and the Hawaii Air National Guard's 199th Fighter (interceptor) Squadron, 154th Wing, stationed at Hickam Air Force Base. It keeps these key entities informed on a real-time basis of bulletins crucial to these agencies. The warning systems in other states are similar.

Tsunami Warning System: A national and international network of warning points are connected together to provide timely exchange of tsunami warning information. In the United States, it is known as the Tsunami Warning System (TWS). Information is relayed to a wide range of government, civil defense, military, and international tsunami research/warning points within each country or area.

National Earthquake Information Center (NEIC): The US Geological Survey operates the National Earthquake Information Center, located in Golden, Colorado. The NEIC issues rapid reports for those earthquakes that register at least 4.5 on the Richter scale in the United States, or 6.5 on the Richter scale (or are known to have caused damage) anywhere else in the world. Public warning reports are disseminated in the affected areas via the NWR and EAS systems.

CHAPTER FOUR

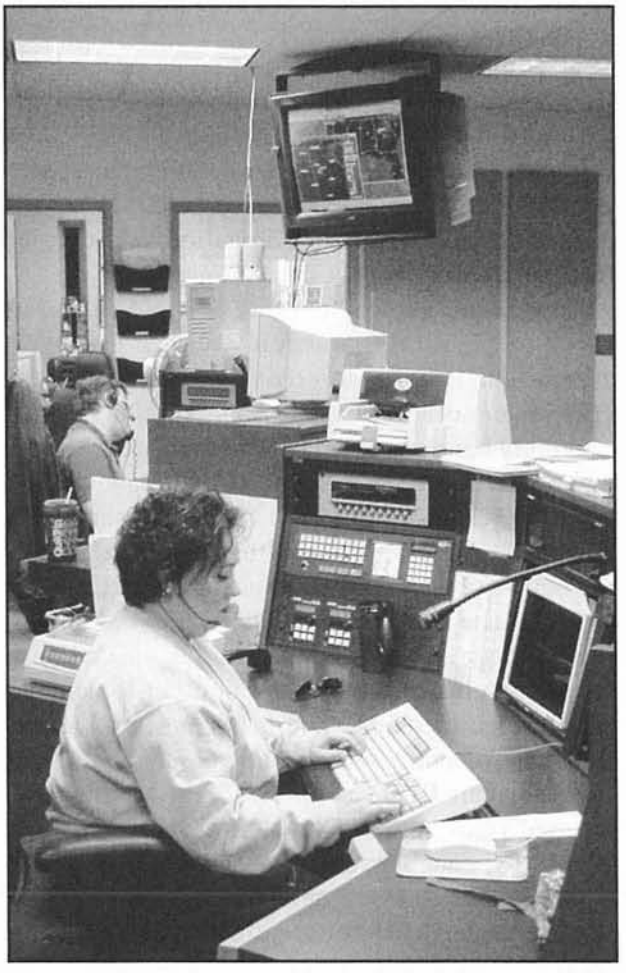
Served Agency Communication Systems

Most served agencies will have their own communication systems and equipment, ranging from modest to complex. In our ever-broadening role as emergency communicators, we may be asked to operate some of this equipment. If this occurs, you must become familiar with its operation.

Your emcomm group should work with the served agency well in advance to determine whether the agency will need you to use its equipment, and under what conditions. Many of these radio systems are quite different from ham radio, and special training may be required.

In addition to different equipment, on-air procedures will definitely be different. Training and drills may be necessary to make Amateur Radio emcomm operators proficient.

State and Local Government Radio Systems: These systems might include those licensed to police, fire, sheriffs, highway and other state, county, or city departments. If you are asked to use any of these systems, be sure to learn their standard operating procedures, and "phonetic alphabet" system if one is used. Some departments may use familiar ITU Phonetics, some will use military systems and still others will make them up as they go along. In addition, a few departments still use a "10 code" or something similar, but most are moving away from special codes in favor of plain language.



A modern county emergency communications center.

Be careful not to lapse into a ham radio operating style. Casual conversations are prohibited by FCC rules and are usually not permitted by the agency. All transmissions must be directly related to the agency's mission.

Many police agencies are licensed for operation on 155.475 MHz, sometimes known as the "National Police Frequency." The FCC has set aside this channel to allow intercommunication between any police agency, regardless of state or jurisdiction. Unfortunately, many departments are not aware of its intended use and treat it as their own private "car to car" channel. Many will not know they have a common channel since they use "channel designators" rather than frequencies. In addition, CTCSS was not supposed to be used on this channel to ensure inter-agency compatibility, but many departments use it anyway. This may become important if different police agencies must intercommunicate with each other in an emergency. If one or more use CTCSS, they will need to disable it by placing their radios in the "monitor" mode, if possible.

Medical Radio Systems: In order to standardize emergency medical radio systems across the country, the FCC assigned a number of dedicated frequencies. In theory, every ambulance in the country should be equipped to use all these frequencies. In practice, true compatibility is usually limited to a specific region.

The older system, often called "MedStar," used 10 simplex VHF frequencies with a dial-type pulsed-tone encoder to signal specific hospitals. This system is still in use in some rural areas, but is quickly being replaced by systems that are more modern. The newer Emergency Medical Radio Service uses 10 UHF duplex frequency pairs; one assigned to the hospital, the other to the ambulance and seven VHF simplex channels. The UHF channel sequence is designated "Med 1" to "Med 10." In some cases, the hospital's radio is located on a nearby mountain or tall tower in order to achieve the required coverage, and it is connected to the emergency department by a radio or telephone link.

American Red Cross: ARC has a nationally licensed frequency (47.42MHz) that can be used by all ARC chapters, and is intended primarily for disaster or emergency operations. This common channel ensures that ARC units responding from various chapters will be able to communicate with each other. Some chapters also use 47.50MHz. In addition, certain chapters may rent space on commercial systems or license their own VHF or UHF systems for day-to-day operations.

Janet Shadle, KG4JBB and Daniel Sullivan, KO1D at their posts during a simulated airplane crash exercise.

Types of Served-Agency Radio Systems

In larger jurisdictions, each agency will probably have its own radio system, completely independent of all other radio users in the same area. This is especially true of large city and state police and fire radio systems. Many agencies have more than one channel, assigned to different purposes. For instance, a fire department might have a "dispatch" channel, and one or more "fireground" channels. This allows local operations at a fire scene to be kept separate from on-going dispatch operations. A police department may have a separate channel for detectives, or one for each precinct. These systems may be on repeaters or use simplex frequencies.

The FCC allocates specific radio frequencies to different types of agencies, and some for multi-agency use. For instance, a frequency designated for use by police agencies may only be used for police business. The same is true of fire radio allocations. "Local Government" allocations may be used for any legitimate local government function.

In addition to "simple" systems where each user group has its own frequency, there are three different types of systems that allow multiple user groups to share resources. These are known as "community repeaters," "trunked repeater systems," and "shared simplex systems."

Community Repeater Systems: Unlike Amateur Radio repeater systems, a "community" or "shared" repeater uses a different CTCSS tone for each of several user groups. For instance, a city might have one repeater shared by the water, public works and sanitation departments, licensed as a single "local government" radio system. Since each department uses a different CTCSS tone, they will not normally hear each other's conversations, but only one department can use the system at any given moment. Some very small rural towns may even combine fire and police department operations on the same system, either on a repeater or simplex frequency.

When using any shared frequency—repeater or simplex—it is important to press the "monitor" button for a moment before transmitting. This disables the CTCSS decoder, temporarily allowing you to hear any transmissions being made on the frequency. Some mobile radios automatically switch to "monitor" mode when the mic is removed from its hang-up clip. In this way, you can be certain that no one else is using the channel before making your call.

In an emergency situation, these shared channel systems can quickly become overloaded. A common practice is to end all non-essential communications or perhaps move them to an Amateur system instead.

Trunked Systems: Trunked systems provide an efficient means for several "low volume" users to share a single radio system. They use several co-located repeaters tied together, using computer control to automatically switch a call to an available repeater. When one radio in a group is switched to a new frequency, all the others in the group automatically follow. This is accomplished by having a computer controller move the conversation from frequency to frequency in accordance with a pre-established algorithm. The number of available frequencies in the system depends on its design, and the number of different user groups. Channel switching and assignment data is transmitted on a dedicated channel. Unlike a shared single-frequency repeater system using multiple CTCSS tones, a trunked system will provide almost instant on-demand clear channels in normal usage. Amateur Radio does not currently use this type of system.

In emergency situations, however, most trunked systems suffer from a lack of reserve capacity. To keep designs cost effective, there are always many more user groups than available channels. The number of available channels is designed to handle the normal day-to-day communications load. When an emergency occurs, these systems can be quickly overloaded with calls, and finding a clear channel can be difficult or impossible.

One "solution" to this problem is to assign certain users or user groups "priority" over others. If all the available channels are occupied, a higher priority user will bump the lowest priority user off the system and take over the channel. Priority status can either be full time or turned on in an emergency, depending on the system's design.

APCO Project 25 Radio Systems: In the 1990s, a new public safety radio system was developed to deal with problems of interoperability between agencies with different radios. The Association of Public Safety Communications Officers (APCO) created the Project 25 working group, which created what has become known as the Project 25 (P25) Standard. P25 radios are extremely flexible, with both forward and backward compatibility. This means that they can be configured to operate in both analog and digital modes, and as part of trunked and conventional radio systems. P25 radio systems are becoming more common across the country as federal funds become available.

The advantages of P25 systems are obvious. Radios from several manufacturers can be programmed to communicate with each other seamlessly, as can radios from different agencies and jurisdictions. Digital modes offer excellent audio quality, and optional encrypted modes offer message and data security. The disadvantages are less obvious. While P25 digital systems work well in urban environments, they are not as effective in rural or mountainous areas. While analog signals can fade in and out, digital signals, are either there or they're not, just like a digital cellular telephone signal.

Telephone Systems

Telephone systems in use by public service agencies vary greatly. The served agency should be able to provide training in its use. Most telephone systems come with user manuals, and if possible, a copy of one should be included in your group's training materials.

Most business telephone systems allow the fol-

lowing basic functions, with which you should be familiar:

Answering incoming calls
Placing outside calls
Placing and answering intercom calls
Making "speed dial" calls
Overhead paging
Placing calls on hold, and then retrieving them
Transferring calls to another extension
Transferring calls to voice mail, if available
Retrieving calls from a voice mailbox

There may be other more advanced functions available, but in most cases, you will not need to learn them for temporary operations. However, it is always a good idea to keep the user's manual nearby.

Satellite Telephones

Satellite phones and data terminals are becoming more common among served agencies as the cost of ownership and airtime decreases. As of this writing, satellite telephone/data service is offered by a number of companies, including Inmarsat, Iridium, Thruway and Globalstar. Some of the services cover much of the earth's surface, others only certain regions. Of these, Iridium's 66-satellite low earth orbit (LEO) constellation has the most coverage with 100%, followed by Inmarsat at 98% of the earth's total surface, and Globalstar with 80% land-area coverage. Thuraya, based in the United Arab Emirates, covers most of Europe, the Middle East and North Africa.

Some phones or terminals require that an antenna be pointed directly at the satellite, others do not, but all require line-of-sight to the satellite. Some are handheld; others are contained in briefcases and must be set up before operating. In addition to voice communication, some companies offer paging, fax and data transmission, although at slower speeds than a typical land-based dial-up connection. A few phones also integrate a terrestrial cellular phone in the same unit.

Calls are typically expensive when compared to cellular telephone calls. All calls made through these systems are considered to be "international" calls, and each company has one or more "country codes." If you need to use one of these phones, keep conversations short and to the point. While most of the phones are fairly simple to use, due to the wide variety of phones and services it is essential that users be fully trained in their use.

Satellite Data Systems

Satellite systems in use by public service agencies also vary greatly. Some are used for two-way data and voice communication, others for one-way reception of voice, data or video. One popular system is the NOAA Emergency Management Weather Information System (EMWINS) system, which allows emergency management officials to obtain up-to-the-second weather maps and information. This system recently underwent a complete revision. If you were trained on the older system, you may need to be retrained.

As with many other served agency systems, the agency will have to provide training in their use if they want you to be able to operate this equipment.

Other Agency-Owned Equipment

In addition to radio and telephone systems, you may need to use fax machines, copiers, computers, and similar devices. Since many of us use these items every day at work, learning their operation should not be a problem in most cases. However, some copiers and computer programs are quite complicated and may require instruction in their use. Computer software used in public safety applications is usually specially written for the purpose and may require extensive training in the rare situation where you will be required to use the system.

CHAPTER FIVE

Basic Communication Skills

Life and death communications are not part of our daily experience. Most of what we say and do each day does not have the potential to severely impact the lives and property of hundreds or thousands of people. In an emergency, any given message can have huge and often unintended consequences. An unclear message, or one that is modified, delayed, mis-delivered or never delivered at all can have disastrous results.

Listening

Listening is at least 50% of communication. Discipline yourself to focus on your job and "tune out" distractions. If your attention drifts at the wrong time, you could miss a critical message.

Listening also means avoiding unnecessary transmissions. A wise person once said, "A man has two ears and one mouth. Therefore he should listen twice as much as he talks." While you are asking, "when will the cots arrive?" for the fourth time that hour, someone else with a life and death emergency might be prevented from calling for help.

Sometimes the job of listening is complicated by noise. You might be operating from a noisy location, the signal might be weak or other stations may be causing interference. In each of these cases, it helps to have headphones to minimize local noise and help you concentrate on the radio signal. Digital Signal Processing (DSP), filters and other technologies may also help to reduce radio noise and interference.

Microphone Techniques

Even something as simple as using your microphone correctly can make a big difference in intelligibility. For optimum performance, hold the mic close to your cheek, and just off to the side of your mouth. Talk across, rather than into, the microphone. This will reduce breath noises and "popping" sounds that can mask your speech.

Speak in a normal, clear, calm voice. Raising your voice or shouting can result in over-modulation and distortion, and will not increase volume at the receiving end. Speak at a normal pace—rushing your words can result in slurred and unintelligible speech. Pronounce words carefully, making sure to enunciate each syllable and sound.

Radios should be adjusted so that a normal voice within 2 inches of the mic element will produce full modulation. If your microphone gain is set so high that you can achieve full modulation with the mic in your lap, it will also pick up extraneous background noise that can mask or garble your voice. A noise-canceling microphone is a good choice since it blocks out nearly all unwanted background noise, and is available in handheld and headset boom mics. Headset boom microphones are becoming less expensive and more popular, but care should be taken to choose one with a cardioid or other noise canceling type element. Many low-cost headset boom mics have omni-directional elements, and will pick up extraneous noise.

"Voice operated transmission" (VOX) is not recommended for emergency communication. It is too easy for background noise and off-air operator comments to be accidentally transmitted, resulting in embarrassment or a disrupted net. Use a hand or foot switch instead.

When using a repeater, be sure to leave a little extra time between pressing the push-to-talk switch and speaking. A variety of delays can occur within a system, including CTCSS decode time, and transmitter rise time. Some repeaters also have a short "kerchunk" timer to prevent brief key-ups and noise from keying the transmitter. It also gives time for some handhelds to come out of the "power-saver" mode. Leaving extra time is also necessary on any system of linked repeaters, to allow time for all the links to begin transmitting. These techniques will ensure that your entire message is transmitted, avoiding time-wasting repeats for lost first words.

Lastly, pause a little longer than usual between transmissions any time there is a possibility that other stations may have emergency traffic to pass from time to time. A count of "one, one thousand" is usually sufficient.

Brevity & Clarity

Each communication should consist of only the information necessary to get the message across clearly and accurately. Extraneous information can distract the recipient and lead to misinterpretation and confusion. If you are the message's author and can leave a word out without changing the meaning of a message, leave it out. If the description of an item will not add to the understanding of the subject of the message, leave it out. Avoid using contractions within your messages. Words like "don't" and "isn't" are easily confused. If someone else has drafted the message, work with the author to make it more concise.

Make your transmissions sound crisp and professional, like the police and fire radio dispatchers and the air traffic controllers. Do not editorialize, or engage in chitchat. An emergency net is no place for "Hi Larry, long time no hear", "Hey, you know that rig you were telling me about last month...." or any other non-essential conversation.

Be sure to say exactly what you mean. Use specific words to ensure that your precise meaning is conveyed. Do not say, "that place we were talking about," when "Richards School" is what you mean. Using non-specific language can lead to misunderstandings and confusion.

Communicate *one complete subject* at a time. Mixing different subjects into one message can cause misunderstandings and confusion. If you are sending a list of additional food supplies needed, keep it separate from a message asking for more sand bags. Chances are that the two requests will have to be forwarded to different locations, and if combined one request will be lost.

An emergency communications van belonging to the Tri-State Amateur Radio Club in Cresco, Iowa.

Plain Language

As hams, we use a great deal of "jargon" (technical slang) and specialized terminology in our daily conversations. Most of us understand each other when we do, and if we do not on occasion it usually makes little difference. In an emergency, however, the results can be much different. A misunderstood message could cost someone's life.

Not everyone involved in an emergency communication situation will understand our slang and technical jargon. Even terms used by hams vary from one region to another, and non-hams will have no knowledge of most of our terminology. Hams assisting from another region might understand certain jargon very differently from local hams.

For these reasons, all messages and communications during an emergency should be in plain language. "Q" signals (except in CW communication), 10 codes and similar jargon should be avoided. The one exception to this is the list of standard "pro-words" (often called "pro-signs") used in amateur traffic nets, such as "clear", "say again all after" and so on.

Avoid words or phrases that carry strong emotions. Most emergency situations are emotionally charged already, and you do not need to add to the problem. For instance, instead of saying, "horrific damage and people torn to bits," you might say "significant physical damage and serious personal injuries."

Phonetics

Certain words in a message may not be immediately understood. This might be the case with an unusual place name, such as "Franconia" or an

unusual last name, like "Smythe." The best way to be sure it is understood correctly is to spell it. The trouble is, if you just spell the word using letters, it might still be misunderstood, since many letters sound alike at the other end of a radio circuit. "Z" and "C" are two good examples. For that reason, radio communicators often use "phonetics." These are specific words that begin with the letter being sent. For instance, "ARRL" might be spoken as "alpha romeo romeo lima".

To reduce requests to repeat words, use phonetics anytime a word has an unusual or difficult spelling, or may be easily misunderstood. Do not spell common words unless the receiving station asks you to. In some cases, they may ask for the phonetic spelling of a common word to clear up confusion over what has been received. Standard practice is to first say the word, say "I spell," then spell the word phonetically. This lets the receiving station know you are about to spell the word he just heard.

Several different phonetic alphabets are in common use, but most hams and public safety agencies use the ITU Phonetic Alphabet, shown below, and others use military alphabets.

Many hams like to make up their own phonetics, especially as a memory aid for call signs, and often with humorous results. Unfortunately, this practice has no place in emergency communication. In poor conditions, unusual phonetic words might also be misunderstood. We need to be sure that what we say is always interpreted exactly as intended—this is why most professional communicators use standardized phonetics.

ITU Phonetic Alphabet

A—alfa (AL-fa)
B—bravo (BRAH-voh)
C—charlie (CHAR-lee)
D—delta (DELL-tah)
E—echo (ECK-oh)
F—foxtrot (FOKS-trot)
G—golf (GOLF)
H—hotel (HOH-tell)
I—india (IN-dee-ah)
J—juliet (JU-lee-ett)
K—kilo (KEY-loh)
L—lima (LEE-mah)
M—mike (MIKE)
N—november (no-VEM-ber)
O—oscar (OSS-cah)
P—papa (PAH-PAH)
Q—quebec (kay-BECK)
R—romeo (ROW-me-oh)
S—sierra (SEE-air-rah)
T—tango (TANG-go)
U—uniform (YOU-ni-form)
V—victor (VIK-tor)
W—whiskey (WISS-key)
X—x-ray (ECKS-ray)
Y—yankee (YANG-key)
Z—zulu (ZOO-loo)

Numbers are somewhat easier to understand. Most can be made clearer by simply "over-enunciating" them as shown below.

One: "Wun"	Two: "TOOO"
Three: "THUH-ree"	Four: "FOH-wer"
Five: "FY-ive"	Six: "Sicks"
Seven: "SEV-vin"	Eight: "Ate"
Nine: "NINE-er	Zero: "ZEE-row"

Numbers are always pronounced individually. The number "60" is spoken as "six zero", not "sixty". The number "509" is spoken as "five zero nine", and not as "five hundred nine" or "five oh nine".

Pro-words

Pro-words, called "pro-signs" when sent in Morse Code or digital modes, are procedural terms with specific meanings. ("Pro" is short for "procedural.") They are used to save time and ensure that everyone understands precisely what is being said. Some pro-words are used in general communication, others while sending and receiving formal messages.

Voice	*Morse/ Digital**	*Meaning and function*
Clear	SK	End of contact. In CW, SK is sent before final identification
Over	KN	Used to let a specific station know to respond
Go ahead	K	Used to indicate that any station may respond
Out	CL	Leaving the air, will not be listening
Stand by	AS	A temporary interruption of the contact
Roger	R	Indicates that a transmission has been received correctly and in full

* Two letters are sent as one character in CW

Tactical Call Signs

Tactical call signs can identify the station's location or its purpose during an event, regardless of who is operating the station. This is an important concept. The tactical call sign allows you to contact a station without knowing the FCC call sign of the operator. It virtually eliminates confusion at shift changes or at stations with multiple operators.

Tactical call signs should be used for all emergency nets and public service events if there are more than just a few participants.

If one does not already exist, the NCS may assign the tactical call sign as each location is "opened." Tactical call signs will usually provide some information about the location or its purpose. It is often helpful if the tactical call signs have a meaning that matches the way in which the served agency identifies the location or function. Some examples are:

"Net"—for net control station

"Springfield EOC"—for the city's Emergency Operations Center

"Firebase 1"—for the first fire base established, or a primary fire base

"Checkpoint 1"—for the first check point in a public service event

"Canyon Shelter"—for the Red Cross shelter at Canyon School

"Repair 1"—for the roving repair vehicle at a bike-a-thon

"Mercy"—for Mercy Hospital

Calling with Tactical Call Signs

If you are at "Aid 3" during a directed net and want to contact the net control station, you would say "Net, Aid 3" or, in crisper nets (and where the NCS is paying close attention), simply "Aid 3". If you had emergency traffic, you would say "Aid 3, emergency traffic," or for priority traffic "Aid 3, priority traffic."

Notice how you have quickly conveyed all the information necessary, and have not used any extra words.

If you have traffic for a specific location, such as Firebase 5, you would say "Aid 3, priority traffic for Firebase 5." This tells the NCS everything needed to correctly direct the message. If there is no other traffic holding, the NCS will then call Firebase 5 with, "Firebase 5, call Aid 3 for priority traffic."

Note that no FCC call signs have been used so far. None are necessary when you are calling another station.

Station Identification

In addition to satisfying the FCC's rules, proper station identification is essential to promoting the efficient operation of a net. The FCC requires that you identify at ten-minute intervals during a conversation and at the end of your last transmission. During periods of heavy activity in tactical nets it is easy to forget when you last identified, but if you identify at the end of each transmission, you will waste valuable time. What to do?

The easiest way to be sure you fulfill FCC station identification requirements during a net is to give your FCC call sign as you complete each *exchange*. Most exchanges will be far shorter than ten minutes. This serves two important functions:

1) It tells the NCS that you consider the exchange complete (and saves time and extra words)

2) It fulfills all FCC identification requirements.

Completing a Call

After the message has been sent, you would complete the call from Aid 3 by saying "Aid 3, <*your call sign*>". This fulfills your station identification requirements and tells the NCS that you believe the exchange to be complete.

If the Net Control Station believes the exchange is complete, and Aid 3 had forgotten to identify, then the NCS should say, "Aid 3, do you have further traffic?" At that point, Aid 3 should either continue with the traffic, or "clear" by identifying as above.

For this method to work properly, the NCS must allow each station the opportunity to identify at the close of an exchange.

• A Review of Habits to Avoid:

• Thinking aloud on the air: "Ahhh, let me see. Hmm. Well, you know, if..."

• On-air arguments or criticism

• Rambling commentaries

• Shouting into your microphone

• "Cute" phonetics

• Identifying every time you key or un-key the mic

• Using "10" codes, Q-signals on phone, or anything other than "plain language"

• Speaking without planning your message in advance

• Talking just to pass the time.

CHAPTER SIX

Introduction to Emergency Nets

The purpose of any net is to provide a means for orderly communication within a group of stations. An "emergency" net is a group of stations who provide communication to one or more served agencies, or to the general public, in a communications emergency. An emergency net may be formal or informal, depending on the number of participants and volume of messages.

Net Formats

Directed (formal) Nets: In a directed net, a "net control station" (NCS) organizes and controls all activity. One station wishing to call or send a message to another in the net must first receive permission from the NCS. This is done so that messages with a higher priority will be handled first, and that all messages will be handled in an orderly fashion. Directed nets are the best format when there are a large number of member stations. (Be careful not to confuse "formal nets" with "formal messages." There is no definite link between the two. A formal net may handle informal messages, and vice versa.)

Open (informal) Nets: In an open net, the NCS is optional. Stations may call each other directly. When a NCS is used at all, he usually exerts minimal control over the net. The NCS may step in when the message volume increases for short periods, or to solve problems and keep the net operating smoothly. Open nets are most often used when there are only a few stations and little traffic.

Types of Emergency Nets

Emergency nets may have different purposes, and a given emergency may require one or more of each type of net. During a small operation, all functions may be combined into one net.

KQ6HF

(Left to right): Ken Nelson, W6NEL, James Nagel, AB0WM and Renny Thomas, KC6LQV at work in the San Bernardino, California County Fire Department Communications Support Unit.

- A *traffic net* handles formal written messages in a specified (i.e. ARRL) format. The nets operated by the National Traffic System (NTS) are an excellent example of traffic nets. ARES or RACES traffic nets may be directed or open depending on their size.
- *Tactical nets* are used for real-time coordination of activities related to the emergency. This is a faster moving, often less formal operation. Messages are usually brief, and frequently unwritten. A tactical net usually has a NCS, but may be

directed or open. The NCS may have other duties or responsibilities as well.

• A *"resource" or "logistics" net* may be needed to acquire resources and volunteers, and handle assignments. It is usually a directed net. Resource nets accept check-ins from arriving volunteers, who are then directed to contact an appropriate station or to proceed to a specific location. It might also be used to locate needed resources, such as equipment, food, water and other supplies for emcomm volunteers.

• An *information net* is usually an open net used to collect or share information on a developing situation, without overly restricting the use of the frequency by others. Net members send updated local information as needed, and official bulletins from the served agency may be sent by the NCS (if the net has one), an agency liaison station or an Official Bulletin Station (OBS). The NCS and many of the participants monitor the frequency, but a "roll call" is seldom taken and stations may not be expected to check in and out of the net. The operation of an information net also serves as notice to all stations that a more formal net may be activated at any moment if conditions warrant. A good example is a SKYWARN weather net activated during a severe storm watch.

Checking Into an Emergency Net

There are two situations where you will need to "check in" to a net.

1. When you first join the net.
2. When you have messages, questions or information to send.

If you are part of the organization operating the net, simply follow the instructions for checking into directed and open nets as discussed below.

To become part of a ***directed net***, listen for the NCS to ask for "check-ins" and listen to any specific instructions, such as "check-ins with emergency traffic only." At the appropriate time, give only your call sign. If you have a message to pass, you can add, "with traffic." If it is an emergency message, say "with emergency traffic." The same is true for stations with priority traffic. Wait for a response before offering more information. Checking into a directed net when the NCS has not asked for check-ins is usually considered a bad practice. However, if a long period passes with no request, you might wait for a pause in the net's activity and briefly call the NCS like this: "Net control, W1FN, with traffic."

To check in to an ***open net*** for the first time, briefly call the net control station as above. If there appears to be no NCS, call anyone on the net to find out if anyone is "in charge" and make contact with them. If you are already part of the net and have a message to send, simply wait for the frequency to be clear before calling another station.

If you are ***not*** **part of the organization** operating the net, do not just check in and offer to assist. Listen for a while. Be sure you have something specific to offer before checking in (such as the ability to deliver a message close to your location when none of the regular net members can). If they really do seem to need help that you feel you can provide, you might check in briefly to ask if they have a "resource" net in operation, then switch to that frequency. If not, make a brief offer of assistance to the NCS.

Do not be too surprised if you receive a cool reception to your offer of help. It is usually nothing personal. Emergency nets are serious business. Most emcomm managers prefer to deal with people with known training and capabilities, and with whom they have worked before. You may not have the experience, skills or official credentials they require—and they have no way of knowing what your true capabilities are. Some emcomm managers will assign you as an apprentice, logger, or as a "runner." If you are given such an opportunity, take it! It is all good experience and a great way to introduce yourself to the group. Better yet, become involved with your local emcomm group now—do not wait for the next disaster.

Passing Messages

If you told the NCS you have traffic to send when you checked in, he will probably ask you to "list your traffic" with its destination and priority. After you send your list, the NCS will direct you to pass each message to the appropriate station in the net, either on the net frequency, or another frequency to avoid tying up the net. When moving to another frequency to pass the message, always check to see if the frequency is in use before beginning.

When you are asked by the NCS to send your message, the standard procedure is for the NCS to tell the receiving station to call the sending station.

The entire exchange might sound like this:

NCS: "W1AW, list your traffic."

You: "W1AW, two priority for Springfield EOC,

one welfare for the Section net."

NCS: "Springfield EOC, call W1AW for your traffic."

Springfield EOC: "W1AW, Springfield EOC, go ahead."

You: "Number 25, Priority..."

(After you have sent your messages to the Springfield EOC, the NCS will next direct the section net liaison station to call you for their message.)

When you have finished, simply sign with any tactical call sign and your FCC call.

(You will learn more about messages and message handling and "emergency," "priority," and other precedences later.)

"Breaking" the Net

If the net is in progress, and you have emergency traffic to send, you may need to "break" into the net. Procedures for doing this vary from net to net, but the most common method is to wait for a pause between transmissions and simply say, "Break, WA1ZCN." The NCS will say, "Go ahead WA1ZCN," and you respond, "WA1ZCN with emergency traffic."

Checking Out of an Emergency Net

Always let the NCS know when you are leaving the net, even if it is only for a few minutes. If the NCS believes you are still in the net, they may become concerned about your unexplained absence. This could result in someone being unnecessarily dispatched to check on your well-being.

There are three reasons for checking out of (leaving) a net.

- The location of your station is closing.

If the NCS has given you directions to close the location, simply acknowledge the request, and sign with your tactical call sign, if you are using one, and your FCC call sign. If the order to close has come from a local official, state that your location has been closed, along with the name and title of the official who ordered it, and sign off as above. Long "goodbyes" only tie up the net needlessly, and do not sound very professional.

- You need a break and there is no relief operator.

Tell the NCS that you will be away from the radio for a certain length of time, the reason and sign with your tactical call sign, if you are using one, and your FCC call sign.

- You have turned the location over to another operator.

Tell the NCS that you have turned the station over to (give the new operator's name and FCC call sign), and that you are leaving. Sign with your tactical call sign, if you are using one, and your FCC call sign.

There are two special situations to be aware of:

If someone in authority asks you, such as a law enforcement officer, to move your station, then move immediately and without argument. Notify the NCS of the situation at the first appropriate opportunity.

If you are requested by someone in authority to turn off your radio, or to refrain from transmitting, do so immediately and *without question*. Do not notify Net Control until you have permission to transmit again, and can do so safely. There is usually a good reason for such a request. It may be an issue of security, or it may be a potential hazard, such as an explosive device that could be triggered by RF energy.

Levels of Nets

Network systems are often "layered" for greater operating efficiency. Some networks are designed

Hams and emergency responders size up a forest fire.

to handle messages within specific areas, and others to handle messages between areas. Think of this much like you would the Interstate Highway System. Local messages (cars) travel between destinations directly on local nets (local roads). When a message has to go to a distant city, it is passed to a regional net (state highway), and if it is *really* distant, to a long distance net (interstate highway). At the other end, it is returned to regional, then local nets for delivery. What has been just described is the extensive National Traffic System (NTS), discussed further below.

ARES or RACES can use a similar structure on a smaller scale. For instance, each city might have a local FM net. A county net would handle messages going from city to city. A section HF net would handle messages from county to county. Any net in such a system could have "liaison" stations to pass into the NTS any messages that need to travel out of the section.

The Nets of the National Traffic System

The National Traffic System (NTS) was created by the ARRL and authored by George Hart, W1NJM in 1949 to handle medium and long distance traffic. In an emergency, The National Traffic System can be used to provide a link from the area impacted by the emergency to the outside world. The National Traffic System is a hierarchical (layered) set of nets, beginning at the local level with the Local nets and continuing through the Section Nets, Region Nets, Area Nets and finally the Transcontinental Corps. Assigned "liaison" stations pass messages between various nets as necessary to reach their final destination. These nets operate in carefully designed "cycles" that allow a message to move smoothly and efficiently from one net to the next across the country in 24 hours. Each message follows a pre-determined path to its destination.

The details of NTS operation are quite complex and well beyond the scope of this book. To learn more about the NTS, visit the NTS section of the ARRL Web site or contact your Section Manager or NTS Section Traffic Manager.

Non-Voice Nets

Emergency nets may also use other modes of communication besides voice (phone). Traffic nets have used CW since the beginning of Amateur Radio, and it is still a viable option for long distance formal traffic. High-speed CW nets can actually handle more messages per hour than most voice nets. Packet communication on VHF and UHF is often used for local communication where accuracy and a record of the message are required. HF digital modes such as AMTOR and PACTOR are used on long distance circuits. Many groups are now experimenting with emergency communication applications for newer modes such as PSK31 on HF and VHF/UHF bands.

The latest end-to-end message handling system to get the attention of the emcomm community is "WinLink 2000," an automatic system that blends radio and Internet transmission paths to permit rapid and seamless e-mail message transfer to stations anywhere on Earth. For most emergencies, it will be possible for stations in the affected area to link to a WinLink 2000 PACTOR node outside the affected area, allowing rapid contact with the outside world.

Most CW nets are directed nets. Packet nets are not generally directed by a human, due the automatic "store and forward" nature of the mode, and are usually operated as open nets with no NCS.

CHAPTER SEVEN

Basic Message Handling

Consider the following scenario: There are 330 hurricane evacuees in a Red Cross shelter. ARES is providing communications, working in 12-hour shifts. An elderly diabetic woman is brought in at 1400 hours. She will require her next dose of insulin by 2300 hours. The manager goes to the radio room. There is an operator wearing a red baseball hat with funny numbers and letters on it. He asks the operator to inform the county EOC of the medication need. The operator calls the Red Cross EOC and says, "Hey, we have a diabetic lady here who will need insulin by 2300 hours," but doesn't write the message down or log the request.

At 2030 hours, the medication has still not been delivered. The shelter manager goes to the radio room to inquire about its status. There is now a different person with a blue baseball cap with a new set of funny letters and numbers. He knows nothing of the earlier request, but promises to "check on it." In the meantime, EOC personnel have discarded the message because it was written on a scrap of paper and had no signature authorizing the order for medication. No one sent a return message requesting authorization.

If each operator had generated and properly logged a formal message, with an authorized signature, it would be a relatively simple matter to track. The informal message has no tracks to follow. Also, by sending a formal message, you are nearly guaranteeing that the receiving station will write it down properly (with a signature) and log it, greatly enhancing it chances of being delivered intact.

Formal vs. Informal Messages

Both formal (written in a specific format, i.e. ARRL) and informal (verbal or written but not in a specific format) messages have their place in emergency communication. In general, informal messages are best used for non-critical traffic that is delivered directly from the author to the recipient. Formal messages are more appropriate when two or more people will handle them before reaching the recipient, or where the contents are critical or contain important details. The most common formal message format is that used by ARRL's NTS, discussed below.

Informal Verbal Messages

Some emergency messages are best sent informally in the interest of saving precious seconds. If you need an ambulance for a severely bleeding victim, you do not have time to compose and send a formal message. The resulting delay could cause the patient's death.

Other messages do not require a formal written message because they have little value beyond the moment. Letting the net control station know where you are or when you will arrive need not be formal. The message is going directly to its recipient, is simple and clear and has little detail. Many of the messages handled on a tactical net fit this description.

Formal Written Message Formats

A standard written message format is used so that everyone knows what to expect. This increases the speed and accuracy with which you can handle messages.

The ARRL message form, or "Radiogram," is a standard format used for passing messages on various nets, and is required for all messages sent through the National Traffic System. While this

format may not be perfect for all applications, it serves as a baseline that can be readily adapted for use within a specific served agency. Regular practice with creating and sending messages in any standard format is recommended.

Components of a Standard ARRL Radiogram

The standard Radiogram format is familiar to most hams from the pads of yellow-green forms available from ARRL Headquarters. The form has places for the following information:

1. The "Preamble" sometimes referred to as "the header," consists of administrative data such as the message number, originating station, message precedence (importance) and date and time of origination. The combination of the message number and the originating station serves as a unique message identifier, which can be traced if necessary.

2. The "Address" includes the name, street address or post office box, city, state, and zip code of the recipient. The address should also include the telephone number with area code since many long distance Radiograms are ultimately delivered with a local phone call.

3. The "Text" of the message should be brief and to the point, limited to 25 words or less when possible. The text should be written in lines of five words (ten if using a keyboard) to make it easier and faster to count them for the "check." Care should be taken to avoid word contractions, as the apostrophe is not used in CW. If a word is sent without the apostrophe, its meaning could be lost or changed. The contraction for "I will" (I'll) has a very different meaning when sent without the apostrophe! Contractions are also more difficult to understand when sent by phone, especially in poor conditions. Commas and other punctuation are also not used in formal messages. Where needed, the "period" can be sent as an "X" in CW and digital modes, and spoken as "X-RAY." The "X" may be used to separate phrases or sentences. but never at the end of the text. Question marks can be used as needed, and are usually spoken as "question mark," and sometimes as "query." Both the X and question mark should be used only when the meaning of the message would not be clear without them.

4. The "Signature" can be a single name, a name and call sign, a full name and a title, "Mom and Dad," and occasionally a return address and phone number—whatever is needed to ensure that the recipient can identify the sender and that a reply message can be sent if necessary.

Details of the Preamble

The preamble or "header" is the section of the ARRL message form where all the administrative details of the message are recorded. There are eight sections or "blocks" in the preamble. Two of them, "time filed" and "handling instructions," are optional for most messages.

Block #1—Message Number

This is any number assigned by the station that first puts the message into ARRL format. While any alphanumeric combination is acceptable, a common practice is to use a numeric sequence starting with the number "1" at the beginning of the emergency operation. Stations who are involved in day-to-day message handling may start numbering at the beginning of each year or each month.

Block #2—Precedence

The precedence tells everyone the relative urgency of a message. In all but one case, a single letter abbreviation is sent with CW or digital modes. On phone, the entire word is always spoken. Within the ARRL format, there are four levels of precedence:

Routine— abbreviated with the letter "R." Most day-to-day Amateur traffic is handled using this precedence—it is for all traffic that does not meet the requirements for a higher precedence. In a disaster situation, routine messages are seldom sent.

Welfare— abbreviated as "W." Used for an inquiry as to the health and welfare of an individual in a disaster area, or a message from a disaster victim to friends or family.

Priority—abbreviated as "P." For important messages with a time limit; any official or emergency-related messages not covered by the EMERGENCY precedence. This precedence is usually only associated with official traffic to, from, or related to a disaster area.

EMERGENCY—there is no abbreviation—the word EMERGENCY is always spelled out. Use this for any message having life or death urgency. This includes official messages from agencies requesting critical supplies or assistance during emergencies, or other official instructions to provide aid or relief in a disaster area. The use of this precedence should generally be limited to traffic originated and signed by authorized agency officials. *Due to the lack of privacy on radio, EMERGENCY messages should only be sent via Amateur Radio when regular communication facilities are unavailable.*

Block #3—Handling Instructions

This is an optional field used at the discretion of the originating station. The seven standard HX pro-signs are:

HXA—(Followed by number.) "Collect" telephone delivery authorized by addressee within (X) miles. If no number is sent, authorization is unlimited.

HXB—(Followed by number.) Cancel message if not delivered within (X) hours of filing time; service (notify) originating station.

HXC—Report date and "time of delivery" (TOD) to originating station.

HXD—Report to originating station the identity of the station who delivered the message, plus date, time and method of delivery. Also, each station to report identity of station to which relayed, plus date and time.

HXE—Delivering station to get and send reply from addressee.

HXF—(Followed by date in numbers.) Hold delivery until (specify date).

HXG—Delivery by mail or telephone—toll call not required. If toll or other expense involved, cancel message, and send service message to originating station.

If more than one HX pro-sign is used, they can be combined like this: HXAC. However, if numbers are used, such as with HXF, the HX must be repeated each time. On voice, use phonetics for the letter or letters following the HX to ensure accuracy, as in "HX Alpha."

Block #4—Station of Origin

This is the FCC call sign of the first station that put the message into NTS format. It is not the message's original author. For instance, you are the radio operator for a Red Cross shelter. The fire station down the street sends a runner with a message to be passed and you format and send the message. You are the "Station of Origin," and fire station is the "Place of Origin," which will be listed in Block 6.

Block #5—The Check:

The "check" is the number of words in the *text section only*. Include any "periods" (written as "X," spoken as "X-Ray"). The preamble, address and signature are not included. After receiving a message, traffic handlers count the words in the message and compare the word count to the "check" number in the preamble. If the two numbers do not agree, the message should be re-read by the sending station to verify that all words were copied correctly. If the message was copied correctly and an error in the check number exists, do not replace the old count with the new count. Instead, update the count by adding a "slash" followed by the new count. For example, if the old count was five, and the correct count was six, change the check to "5/6." For more information on counting words and numbers for the check, follow this link: **www.arrl.org/FandES/ead/teacher/kemp/appendixa.html#words**.

Emergency workers respond in the aftermath of a hurricane.

Block #6—Place of Origin

This is the name of the community, building, or agency where the originator of the message is located, whether a ham or not. This is not the location of the station that first handled the message, which is listed in Block 4, "Station of Origin."

Block #7—Time Filed

This is an optional field, unless handling instruction "Bravo" (HXB) is used. HXB means "cancel if not delivered within X hours of filing time." Unless the message is time sensitive, this field may be left blank for routine messages, but completing the time field is generally recommended for Welfare, Priority and Emergency messages. Many hams use Universal Coordinated Time (UTC) for messages and logging. During emergencies, it is better to use local time and indicators such as PST or EDT to eliminate confusion by served agency personnel.

Block #8—Date

This is the date the message was first placed into the traffic system. Be sure to use the same

date as the time zone indicated in Block 7.

Header Examples

This is how a complete header might look for a CW or digital message:

NR207 P HXE W1FN 10 LEBANON NH 1200 EST JAN 4

This is how the same header would be spoken:

"Number two zero seven Priority HX Echo Whiskey One Foxtrot November

One Zero Lebanon NH One Two Zero Zero EST January four."

A brief pause is made between each block to help the receiving station separate the information. Note that the title of each block is not spoken, with the exception of the word "number" at the beginning, which tells the receiving station that you are beginning the actual message.

Pro-Words and Pro-Signs:

When sending formal traffic, standard "pro-words" or pro-signs" (CW) are used to begin or end parts of the message, and to ask for portions of the message to be repeated. In addition to adding clarity, the use of standard pro-words and pro-signs saves considerable time.

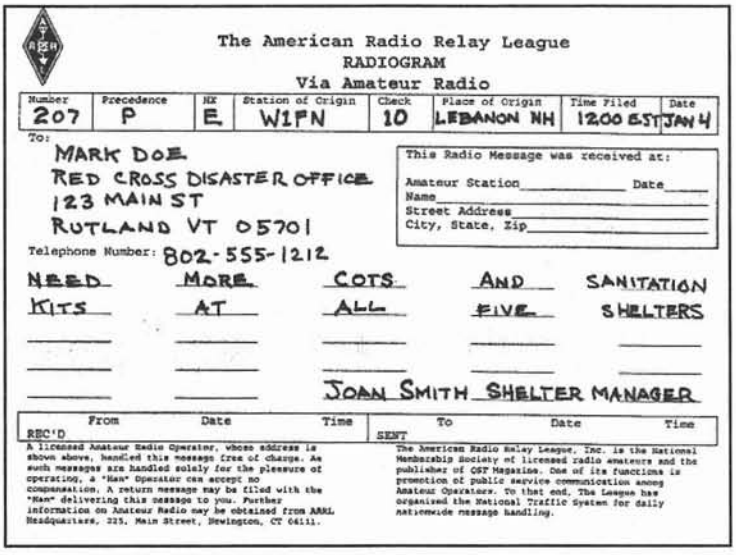
Some pro-words and pro-signs tell the receiving station what to expect next in the address, text and signature portions of the message—they are *not* used while reading the header, since the header follows a pre-determined format. Examples of commonly used pro-words are, "figures" sent before a group consisting of all numerals, "initial" to indicate that a single letter will follow, or "break" to signal the transition between the address and the text, and the text and the signature.

Message Handling Pro-Words, Prosigns And Abbreviations

Pro-Word	*Pro-Sign (CW)*	*Meaning or Example*
BREAK	BT *	Separates address from text and text from signature.
CORRECTION	HH *	"I am going to correct an error."
END	AR *	End of message.
MORE	B	Additional messages to follow.
NO MORE	N	No additional messages. In CW can also mean "negative" or "no"
FIGURES	Not needed	Used before a word group consisting of all numerals.
INITIAL	Not needed	Used to indicate a single letter will follow.
I SAY AGAIN	IMI *	Used to indicate a repeat of a word or phrase will follow.
I SPELL	Not needed	"I am going to spell a word phonetically."
LETTER GROUP	Not needed	Several letters together in a group will follow. Example: ARES, SCTN.
MIXED GROUP	Not needed	Letters and numbers combined in a group will follow. Example: 12BA6
X-RAY	X	Used to indicate end of sentence, as with a "period."
BREAK	BK *	Break; break-in; interrupt current transmission on CW
CORRECT	C	Correct, yes
CONFIRM	CFM	Confirm (please check me on this)
THIS IS	DE	Used preceding identification of your station
HX	HX	Handling instructions, single letter to follow—optional part of preamble
GO AHEAD	K	Invitation for specific station to transmit
ROGER	R	Message understood. In CW, may be used for decimal point in context
WORD AFTER	WA	"Say again word after..."
WORD BEFORE	WB	"Say again word before..."
BETWEEN	-	"Say again between...and ...."
ALL AFTER	AA *	"Say again all after..."
ALL BEFORE	AB	"Say again all before..."

** Two letters are sent as one character.*

Sending a Message with Voice: When the receiving station is ready to copy, read the message at a pace that will allow the receiving station to write it down. Once you are done, if the receiving station has missed any portion of the message they will say, "say again all after____," "say all before," or "say again all between _____ and ____." In some nets, the practice is to say "break" and then unkey between sections of the message so that a station can ask for missing words to be repeated before going on (these repeated words are also known as "fills"). In many nets, the entire message is read first before any fills are requested, to save time. All numbers in groups are spoken individually, as in "three two one five," not "thirty-two fifteen," or "three thousand two hundred and five."



The American Radio Relay League
RADIOGRAM
Via Amateur Radio

Number	Precedence	HX	Station of Origin	Check	Place of Origin	Time Filed	Date
207	P	E	W1FN	10	LEBANON NH	1200 EST	JAN 4

To:
MARK DOE
RED CROSS DISASTER OFFICE
123 MAIN ST
RUTLAND VT 05701
Telephone Number: 802-555-1212

This Radio Message was received at:
Amateur Station _____ Date _____
Name _____
Street Address _____
City, State, Zip _____

NEED MORE COTS AND SANITATION
KITS AT ALL FIVE SHELTERS

JOAN SMITH SHELTER MANAGER

	From	Date	Time		To	Date	Time
REC'D				SENT			

A licensed Amateur Radio Operator, whose address is shown above, handled this message free of charge. As such messages are handled solely for the pleasure of operating, a "Ham" Operator can accept no compensation. A return message may be filed with the "Ham" delivering this message to you. Further information on Amateur Radio may be obtained from ARRL Headquarters, 225, Main Street, Newington, CT 06111.

The American Radio Relay League, Inc. is the National Membership Society of licensed radio amateurs and the publisher of QST Magazine. One of its functions is promotion of public service communication among Amateur Operators. To that end, The League has organized the National Traffic System for daily nationwide message handling.

An example of a typical radiogram.

Here is the entire message as it would be spoken:

"Number two zero seven Priority HX Echo Whiskey One Foxtrot November One Zero Lebanon NH one two zero zero EST January four.

Mark Doe

Red Cross Disaster Office

Figures one two three Main Street

Rutland VT figures zero five seven zero one

Figures eight zero two five five five one two one two

Break

Need more cots and sanitation kits at all five shelters

Break

Joan Smith Shelter Manager

End No more"

Time Savers

What NOT to say: When passing formal traffic, do not add unnecessary words. Since the parts of the header are always sent in the same order, there is no need to identify each of them. The only exception is the word "number" at the beginning of the header. Here is an example of how *not* to read the header of a message on the air:

"Number two zero seven precedence, Priority handling instructions, HX Echo station of origin W1FN check one zero place of origin, Lebanon NH time one two zero zero EST date, January 4

Going to Mark Doe Red Cross Disaster Office Address figures one two three Main Street Rutland VT ZIP figures zero five seven zero one Telephone Figures eight zero two five five five one two one two" This example added many unneeded words to the message, including "station of origin," "check," "time," "going to," "address," "ZIP," and "telephone" and other block titles. If there is something about the message that deviates from the standard format, or if an inexperienced operator is copying the message without a pre-printed form, then some additional description may be necessary, but in most cases, it just wastes time. (The pro-word "figures" is used correctly, and "number" is always spoken before the message number.)

Message Handling Rules

Do not speculate on anything relating to an emergency! There may be hundreds of people listening to what you say (other Amateurs, and the media and general public using scanners) and any incorrect information could cause serious problems for the served agency or others. You do not want to be the source of any rumor.

If your served agency requests an estimate, you can provide that information as long as you make it very clear that it is only an estimate when you send it. For example, saying "The estimated number of homes damaged is twelve" would be acceptable.

Pass messages exactly as written or spoken: In addition to speed, your job as a communicator is to deliver each message as accurately as possible.

Therefore, you must not change any message as you handle it. If it is longer than you would like, you must send it anyway. Apparently, misspelled words or confusing text must be sent exactly as received. Only the original author may make changes. If you note an inaccurate word count in a NTS format message, you must maintain the original count and follow it with the actual count received at your station, i.e.: "12/11."

Should you return a message to the author before first sending it if it seems incorrect or confusing? This is a judgment call. If the apparent error will affect the meaning of the message and the author is easily contacted, it is probably a good idea. Whenever possible, it is a good practice to read each message carefully in the presence of the author before accepting it. This way, potential errors or misunderstandings can be corrected before the message is sent.

Non-Standard Format Messages: Much of the tactical information being passed during a major emergency will not be in ARRL format. It may have much of the same information, but will be in a non-standard format or no format at all. These messages should also be passed exactly as received. If necessary, use the ARRL format and place the entire non-standard message in the "text" section.

The Importance Of The Signature

During an emergency, the messages you handle can easily contain requests for expensive supplies that have a very limited "shelf life" (such as blood for a field hospital), or for agencies that will only respond to properly authorized requests (i.e.: for medivac helicopters). For this reason, it is critical that you include the signature and title of the sender in every message.

Copying Hints

When copying the text of a message by hand, receiving stations should write five words on each line, (or ten words per line if using a keyboard). The standard ARRL Radiogram form is set up for hand copying with spaces for each word, but even if you are writing on whatever happens to be handy, grouping the words five to a line allows for a very quick count after the message is received. Once complete, the receiving operator compares the word count with the check. If okay, the message is "rogered"—if not, the message is repeated at a faster reading speed to locate the missing or extra words.

Modified Message Form for Disasters

While ARRL format messages can handle many different types of information flow, there can be requirements for formats that are unique to an individual agency or type of emergency. Your emcomm group should work with each served agency before the emergency to see which format will best fulfill their needs. A good example is the popular Incident Command System (ICS) form ICS-213 used by most government agencies.

Service Messages

A "service message" is one that lets the originating station know the status of a message they have sent. A service message may be requested by a handling instruction (HX), or may be sent by any operator who has a problem delivering an important message. During emergencies, service messages should only be sent for Priority and Emergency messages.

Logging and Record Keeping

An accurate record of formal messages handled and various aspects of your station's operation can be very useful, and is required by law in some cases. Lost or misdirected messages can be tracked down later on, and a critique of the operation afterward can be more accurate. All logs should include enough detail to be meaningful later on, especially the date and an accurate time. With some agencies, your log becomes a legal document and may be needed at some later time should an investigation occur. In this case, logs should be completed and turned in to the appropriate person for safekeeping and review.

What to Log: Log all incoming and outgoing messages. Record the name of the sender, addressee, the station that passed the message to you, the station to whom the message was sent, the message number, and the times in and out. Keep the written copy of each message in numerical order for future reference.

Also, log which operators are on duty for any given period, and record any significant events at your station. These might include changes in conditions, power failures, meals, new arrivals and departures, equipment failures, and so on.

In addition to the log, copies of all messages should be kept and catalogued for easy retrieval if needed later for clarification or message tracking. Many operators make notes about when the message

was received and sent, and to and from whom, directly on the message form itself. This helps speed up tracking later on. Never rely on your memory.

Should informal messages be logged? This is usually up to the stations involved, and depends on the circumstances. Even informal messages can contain important details that may need to be recalled later. Emergency or Priority messages of any kind, even unwritten messages, should always be logged. Some net control operators like to log every message or exchange, no matter how inconsequential. Others like to log only those with potentially important details.

Log Formats: At a station with little traffic, all information can be included in one chronological log. However, if a large number of messages are being handled and you have a second person to handle logging, separate logs can make it faster and easier to locate information if it is needed later. You might keep one log for incoming messages, one for outgoing messages, and a third for station activities. The NCS will also need to keep a log of which operators are assigned to each station, and the times they go on and off duty.

Who should log: At the net level, logging can be handled in several ways. If activity is low, the net control operator can handle logging. In busy nets, a second person can keep the log as the net's "secretary" and act as a "second set of ears" for the NCS. The logger can be at the NCS, or they might be listening from a different location.

If an "alternate NCS" station has been appointed, they should keep a duplicate log. If they need to "take over" the net at any point, all the information will be at hand, preserving the continuity of the net.

In addition to logs kept at the net level, each individual operator should keep his or her own log. This will allow faster message tracking and provides duplicate information should one station's logs become lost or damaged.

In a fast moving tactical net, keeping a log while on the move may be impossible for individual stations. In this case, the net control station may decide to keep one log detailing the various informal messages passed on the network.

Logging is a good position for a trainee with limited experience, or an unlicensed volunteer. Two experienced and licensed operators can also alternate between on-air and logging duties to help combat fatigue.

Writing Techniques For Message Copying and Logging

Your logs should be clear and legible to be of any use. If only you can read your handwriting, the log will be of little value to the operator who takes the next shift or to the served agency as a legal document. Print in neat block letters on lined paper or a pre-printed log form. A firm writing surface with support for your forearm will reduce fatigue and improve legibility.

Keep both pens and pencils on hand since each works better under different conditions. Logs that will become legal documents should always be written in permanent ink. Some operators prefer special "diver's" pens that will write on wet surfaces at any angle.

Logs should be kept in notebooks to prevent pages from becoming lost. In the case of preprinted log sheets, use a three-ring binder. If more than one log is kept, each should be in its own notebook to prevent confusion and accidental entries. Logs that will become legal documents should be kept in hardbound books with pre-numbered pages so that missing pages will be obvious.

In fast-moving situations, it can be difficult or impossible to keep a log of any kind. If a message, exchange or event should be logged, try to do it as soon as possible afterwards, or ask the NCS to add it as a notation in his log. If there are enough operators to do so, one may be assigned the sole task of logging the net's operations, thus freeing up other net participants to handle messages more quickly.

Message Authoring—Them Or Us?

One of the oldest arguments in emcomm is the question of whether or not emcomm personnel should author (create) agency-related official messages. If your job is strictly communication, and the message is not about the communication function you are providing, the best answer is "no." "Pure" communicators are not generally in a position to create messages on behalf of the served agency. They have no direct authority and usually lack necessary knowledge.

However, you should always work with a message's author to create text that is clear, to the point, and uses the minimum number of words necessary. Once you do this with most agency personnel, they will be happy to send you appropriate messages, since it saves them time, too. If the author tells you to "just take care of the wording

for me," it is still a good idea to get their final approval and signature before sending the message.

If you have additional training for an agency-specific job that involves message origination, this is quite different from the situation of a "pure" communicator. In this case, you may be able to generate an official message if you have been given the authority to do so.

Other messages that can and should be generated by all emcomm operators are those that deal solely with communication. Examples would be messages about net operations and frequencies, and requests for relief operators, radio equipment, supplies, food and water for emcomm personnel.

Message Security & Privacy

Information transmitted over Amateur Radio can never be totally secure, since FCC rules strictly prohibit us from using any code designed to obscure a message's actual meaning. Anyone listening in with a scanner can hear all that is said on voice nets. The federal Communications Privacy Act does not protect Amateur Radio communications, and anything overheard may be legally revealed or discussed. Reporters in disaster-prone areas have been known to purchase digital-mode decoding software for laptops in order to intercept ham radio communications during disasters.

However, this does not mean that you can discuss any message you send with others. Messages sent via Amateur Radio should be treated as privileged information, and revealed only to those directly involved with sending, handling or receiving the message. This must be done to offer at least a minimum level of message security. You cannot prevent anyone from listening on a scanner, but you can be sure they do not get the information directly from you.

Your served agency should be made of aware of this issue, and must decide which types of messages can be sent via Amateur Radio, and using which modes. The American Red Cross has strict rules already in place. In general, any message with personally identifiable information about clients of the served agency should be avoided—this is a good policy to follow with any agency if you are in doubt. Messages relating to the death of any specific person should never be sent via Amateur Radio. Sensitive messages should be sent using telephone, landline fax, courier, or a secure served-agency radio or data circuit.

While we can never guarantee that a message will not be overheard, there are ways to reduce the likelihood of casual listeners picking up your transmissions. Here are some ideas:

Use a digital mode: packet, PSK31, fax, RTTY, PACTOR, digital phone, etc.

Pick an uncommon frequency—stay off regular packet nodes or simplex channels.

Do not discuss frequencies or modes to be used openly on voice channels.

Avoid publishing certain ARES or RACES net frequencies on Web sites or in any public document.

Some agencies use a system of "fill in the blank" data gathering forms with numbered lines. To save time on the radio, all that is sent is the line number and its contents. A casual listener might hear, "Line 1, 23; line 5, 20%; line 7, zero." The receiving station is just filling in the numbered lines on an identical form. Without the form, a casual listener will not have any real information. As long as encryption is not the primary intent, this practice should not violate FCC rules.

Informal Messages

When we send a written ARRL-format message, we do it to preserve accuracy no matter how many people pass the message along. Informal or "tactical" messages are not written out in ARRL format, or not written at all. However, this does not mean that accuracy is any less important. If someone gives you a short message to relay to someone else, you should repeat it as closely to the original as possible. Messages that will be relayed more than once should always be sent in ARRL format to prevent multiple modifications.

Here is an example of what might happen if you are not careful to maintain the precise meaning of the original message:

The original message: "The shelter manager says she needs fifty cots and blankets at Hartley Hill School by tonight."

After being passed through several people: "He says they need a bunch more cots and blankets at that school on the hill."

CHAPTER EIGHT

Net Operating Guidelines

Every organization needs an executive-level manager to oversee the entire operation and ensure that everything runs smoothly. Depending on the type of net, the Net Manager will be responsible for recruiting and training NCS operators, liaison stations and other net members. The Net Manager sets up the net's schedule and makes sure that one or more qualified NCS operators will be available for each session of the net. In a long-term emergency net, the Net Manager may also arrange for relief operators and support services. Some net managers may be responsible for more than one net.

The NCS

Think of the NCS as a "ringmaster" or "traffic cop." The NCS decides what happens in the net, and when. If the EOC has a Priority message for Red Cross Shelter 1, and Medical Station 4 has an Emergency message for Mercy Hospital, it is the NCS's job to make sure that the Emergency message is sent first. He decides when stations will check in, with or without traffic, and whether messages will be passed on the net's frequency or a different one. The NCS needs to be aware of everything going on around him and handle the needs of the net, its members and served agency as quickly and efficiently as possible. It can be a daunting task in a busy and challenging net.

The NCS can be located anywhere, but should be in a position to hear most, if not all, stations in the net. This helps avoid time-consuming "relays." Some groups place their NCS at the EOC or command post, others like to keep them away from the noise and confusion.

The NCS is in charge of one specific net, but should not be responsible for the entire emcomm operation. That is the job of the EC or similar emcomm manager. It is not possible to be in command of all aspects of an emergency response, and still run a net effectively, since both jobs require 100% of your attention.

Net Scripts

Many groups open and close their nets with a standard script. The text of the script lets listeners know the purpose and format of the net. Using a standard script also ensures that the net will be run in a similar format each time it operates, regardless of who is acting as the NCS. A typical net script might look like this:

Opening: This is [call sign], net control station for the New Hampshire ARES/RACES Emergency Net. This is a directed emergency net for liaison stations from all New Hampshire ARES/RACES regions. Please transmit only when requested to, unless you have emergency traffic.

Any station with emergency traffic, please call now. (Stations call in and emergency traffic is passed.)

Any station with priority traffic, please call now. (Stations call in and priority traffic is passed.)

All other stations with or without traffic, please

call now. (Stations call in and any traffic is passed.)

Closing: I would like to thank all stations that checked in. This is [call sign] securing the New Hampshire ARES/RACES Emergency Net at [date and time] returning the [repeater or frequency] to regular use.

The Backup NCS

A backup NCS needs to be readily available should there be an equipment failure at the primary NCS location, or if the primary NCS operator needs to take a break There are two types of backup NCS. Either the Net Manager or the primary NCS, depending on the situation, appoints both. All members of the net should be made aware of the backup NCS assignment early in the net's operation.

The first type is at the same location as the primary NCS operator. The second is a station at a different location that maintains a duplicate log of everything happening during the net. Whenever possible, an offsite backup NCS should be maintained, even if an on-site backup is present. This is especially important during an emergency where antennas can be damaged or power lost. Equipment can fail even during less demanding operations.

Acting as a "fill-in" NCS

Even before you have had a chance to be trained by your group to act as a NCS operator, an opportunity might arise for you handle the job temporarily. During an emergency, anyone and everyone can be asked to take on new and unfamiliar tasks in order to deal with a rapidly changing situation. Fortunately, basic NCS skills are not difficult to teach or learn. Here are some basic dos and don'ts:

- Remember that although you are in control of the net, you are not "God." Treat members with respect and accept suggestions from other experienced members.
- If you are taking over an existing net, try to run it much as the previous NCS did.
- Always follow a script if one is provided. Write your own if necessary, but keep it short and to the point.
- Handle messages in order of precedence: Emergency—Priority—Welfare.
- Speak clearly and in a normal tone of voice. Use good mic technique.
- Make all instructions clear and concise, using as few words as possible.
- Keep notes as you go along. Do not let your log fall behind.
- Write down which operators are at which locations. When one leaves or is replaced, update your notes.
- Ask stations to pass messages off the main net frequency whenever possible.
- All the reading and study in the world will not replace actual experience. You should look for opportunities to practice being the NCS operator well before an emergency occurs.

Net Members

Operators at various sites are responsible for messages going to and from their location. They must listen to everything that happens on the net, and maintain contact with the served agency's people at the site. They assist the served agency with the creation of messages, put them into the appropriate format and contact the NCS when they are ready to be sent.

Whenever possible, two operators should be at each site. When the station is busy, one can handle logging, message origination, and work with the served agency's staff while the other monitors the net, sends messages, and copies incoming traffic. During slower periods, one member can be "off-duty" for rest, meals or personal needs.

Bulletin Stations

In some nets, the NCS does not send out bulletins and other incident related information. That is the role of the "bulletin station." This station relays ARRL bulletins or those authorized by the served agency to all stations in the net. They may also be transmitted on a preset schedule, such as at the top and bottom of each hour. The bulletin station must be located at the served agency or have a reliable communication link to them.

Liaison Stations

Liaison stations pass messages between two different nets. The NCS or Net Manager, depending on the type of organization, usually assigns these stations. Messages may be passed as needed, or on a pre-set schedule. In some cases, a liaison station will monitor one net full time. When a message must be passed to another net, they leave the net temporarily to pass it, and then return. The other net has a liaison station who does exactly the same thing, but in reverse.

In other situations, a single liaison station may

Efficient radio communication leads to efficient action, such as a call for a helicopter to dump water on a forest fire.

need to handle messages going both ways between two nets. There are two ways to do this. You can use two radios to monitor both nets at the same time, a difficult task if either or both nets are busy. The radios antennas must be separated sufficiently to prevent interference between radios when one is used to transmit. In the second method, one radio is used, and the liaison station switches between the two nets on a regular schedule.

Relay Stations

While not a regular net position, a relay station is one that passes messages between two stations in the net that cannot hear each other. Relay stations are generally designated by the NCS on an "as needed" basis. If you can hear a station or stations that the NCS cannot, it is OK to volunteer to act as a relay station.

Workload and Shift Changes

Although it happens frequently, no operator should try to work excessively long hours. When you become tired, your efficiency and effectiveness decline, and your served agency is not getting the best possible service. Net managers and NCS operators should work with the EC or other emcomm manager to ensure that all net members get some rest on a regular basis.

It is a good practice for any replacement NCS, liaison, or net member to monitor the net for at least fifteen minutes and review the logs with the present operator before taking over. This assures continuity in the net's operation.

Non-voice Modes

Packet modes include FM packet, HF packet and PACTOR. Because packet modes can provide an automatic connection between two stations, it is not really proper to speak of a "packet net." Although messages can be transmitted between two stations "keyboard to keyboard" as with RTTY or PSK31, it is usually better to transmit them as "traffic," using the bulletin board or mailbox facility of the terminal node controller (TNC). Packet messages are automatically routed and stored without any action by the receiving station's operator or a NCS.

Non-packet digital modes are not automatic, and may require a NCS operator to manage the net in much the same way as a phone or CW net. These include RTTY, PSK31, AMTOR and GTOR.

CW Procedures: Clean and accurate code sent at 10 words per minute is better than sloppy code sent at 30 words per minute. Sending speed is not a true measure of effectiveness, but accuracy is. When propagation or interference makes communication difficult, or when the receiving operator cannot keep up, it is time to reduce the sending speed. Always send at a speed that the receiving station can copy comfortably.

There are variations used when passing traffic via CW, especially when both stations are operating "full break-in"mode (both stations are capable of receiving signals between each Morse character sent). The receiving station can "break" (stop) the sending station at any point for needed fills, instead of waiting for the entire message to be sent. There are additional special pro-signs used, and interested Amateurs should be familiar with ARRL Publication FSD-218 **www.arrl.org/FandES/field/forms/fsd218.pdf**. This publication is sometimes referred to as the "pink card" and contains CW net procedures as well as a description of the Amateur Message Form, message precedences and Handling Instruction abbreviations.

Procedure Signals (Prosigns) for Morse Code

BK	Invite receiving station to transmit (break)
CL	Going off the air (clear)
CQ	Calling any station (literally, Come Quick)
K	Go, invite any station to transmit
R	All received OK
AA	(Separation between parts of address or signature)
AR	Over, end of message
AS	Please stand by
BT	Separation (break) between address and text; between text and signature
KN 'X'	Go only, invite a specific station 'X' to transmit
SK	End of contact (send before sending your call)

Abbreviations

Fill	Term used to describe missing items (words, characters, numbers etc.) when handling messages in the National Traffic System.
AA	All after (use to get fills)
AB	All before (use to get fills)
ADEE	Addressee (name of the person to whom the message is addressed)
ARL	(Used with "check"—indicates use of ARL numbered message in text.)
BN	Between
SIG	Signed; signature (last part of message)
WA	Word after
WB	Word before

When formatting an ARRL Radiogram message, use abbreviations and prosigns consistently and appropriately. For instance, do not send "R," meaning you have received everything correctly, and then ask for repeats like "AA" (all after) or "AB" (all before).

Interference Problems

If your net experiences interference, the NCS has several options. If the interference is coming from adjacent or co-channel stations who may be unaware of the emergency net, the NCS should politely inform them of the net and ask for their cooperation. Alternatively, the NCS might ask an HF net to move over a few kHz. If the problem cannot be resolved in this manner, each net should have one or more alternative frequencies that it can move to as required. If possible, the frequencies themselves should not be published or mentioned on the air.

Never discuss, acknowledge or try to speak with an intentionally interfering station. Many years of experience has proven that this only encourages the offender. If the interference is making communication difficult, simply announce to the net that everyone should move to the alternate frequency and sign off. Better yet, put a plan in place so that when interference occurs, all net members know to move to the alternate frequency without being told to do so on the air.

If intentional interference persists, the Net Manager or NCS can contact an elected League official or an Official Observer Station, and ask that the FCC be notified of the interference. In some cases, they may be able to track down and contact the responsible station.

CHAPTER NINE

The Incident Command System

In the early 1970s, a disorganized and ineffective multi-agency response to a series of major wild fires in Southern California prompted municipal, county, state and federal fire authorities to form an organization known as Firefighting Resources of California Organized for Potential Emergencies (FIRESCOPE). California authorities had found that a lack of coordination and cooperation between the various responding agencies resulted in overlapping efforts, and gaps in the overall response. Many specific problems involving multi-agency responses were identified by FIRESCOPE. These included poor overall organization, ineffective communication between agencies, lack of accountability, and the lack of a single, universal, and well-defined command structure.

Their efforts to address these difficulties resulted in the development of the original Incident Command System. Although developed for wild fires, the system ultimately evolved into an "all-risk" system, appropriate for all types of fire and non-fire emergencies.

There are other versions of the ICS in use, but the Incident Command System (ICS), as developed by the National Fire Academy (NFA), has been widely recognized as a model tool for the command, control, and coordination of resources and personnel at the scene of an emergency and is used by most fire, police, and other agencies around the country. The use of the ICS is now required by various federal laws for all hazardous material incidents, and in other situations by many state and local laws. The ICS has also been adopted for use in many other countries.

What is the ICS?

The Incident Command System is a management tool designed to bring multiple responding agencies, including those from different jurisdictions, together under a single overall command structure. Before the use of the ICS became commonplace, various agencies responding to a disaster often fought for control, duplicated efforts, missed critical needs, and generally reduced the potential effectiveness of the response. Under ICS, each agency recognizes one "lead" coordinating agency and person, will handle one or more tasks that are part of a single over-all plan, and interact with other agencies in defined ways.

The Incident Command System is based upon simple and proven business management principles. In a business or government agency, managers and leaders perform the basic daily tasks of planning, directing, organizing, coordinating, communicating, delegating and evaluating. The same is true for the Incident Command System, but the responsibilities are often shared between several agencies. These tasks, or *functional areas* as they are known in the ICS, are performed under the overall direction of a single Incident Commander (IC) in a coordinated manner, even with multiple agencies and across jurisdictional lines.

What the ICS is *Not*

Many people who have not studied the full details of the Incident Command System have a variety of erroneous perceptions about what the system means to them and their agencies. To set the record straight, the Incident Command System **is not**:

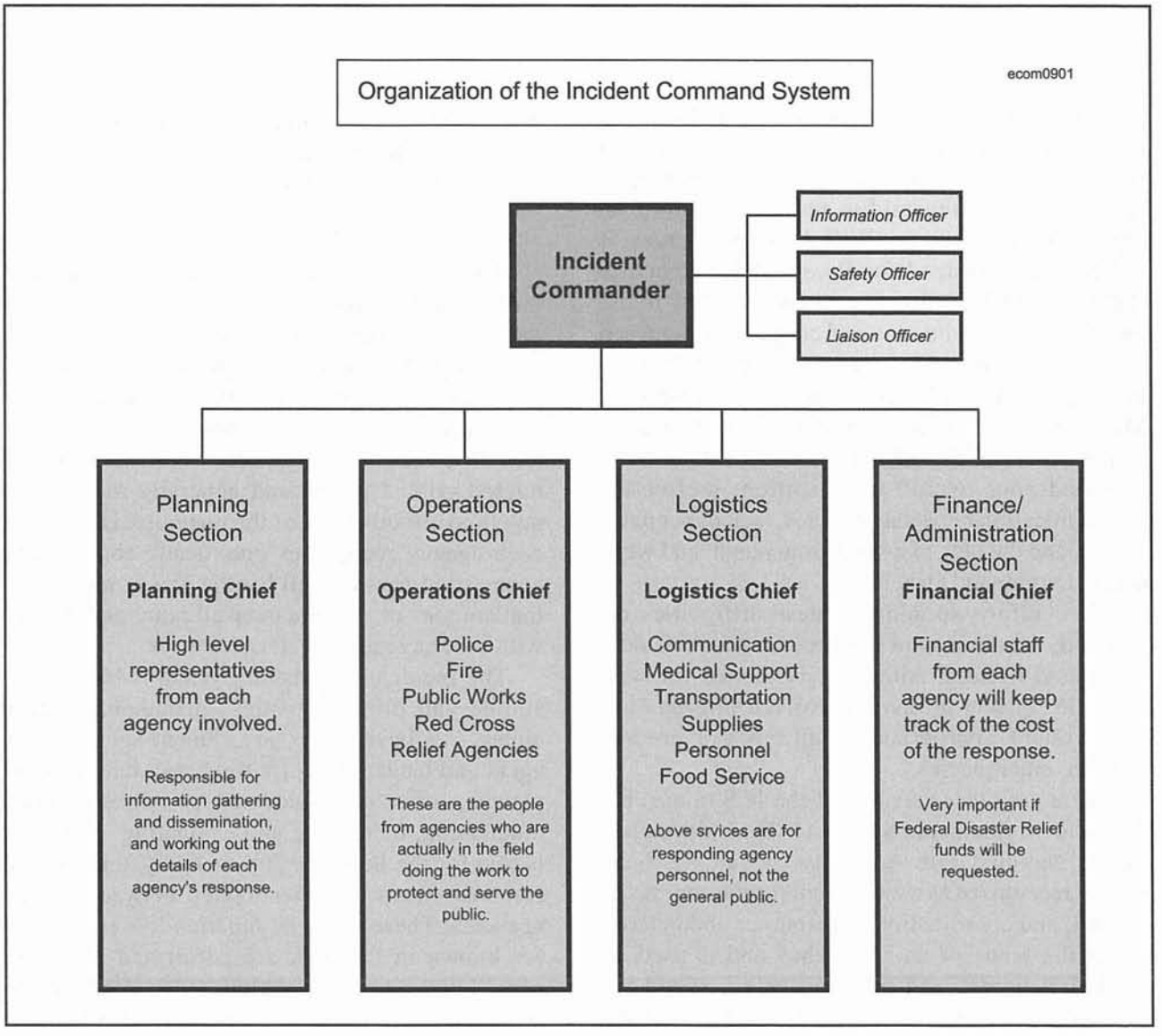
- A fixed and unchangeable system for managing an incident.
- A means to take control or authority away from agencies or departments that participate in the response.
- A way to subvert the normal chain of command within a department or agency.
- Always managed by the fire department or the first agency to arrive on-scene.
- Too big and cumbersome to be used in small, everyday events.
- Restricted to use by government agencies and departments.

The ICS Structure

The Incident Command System has two interrelated parts. They are "management by objectives," and the "organizational structure."

***Management by objectives*:** Four essential steps are used in developing the response to every incident, regardless of size or complexity:

- Understand the policies, procedures and statutes that affect the official response.
- Establish incident objectives (the desired out-



An organizational chart of the incident command system.

come of the agencies' efforts).

• Select appropriate strategies for cooperation and resource utilization.

• Apply tactics most likely to accomplish objectives (assign the correct resources and monitor the results).

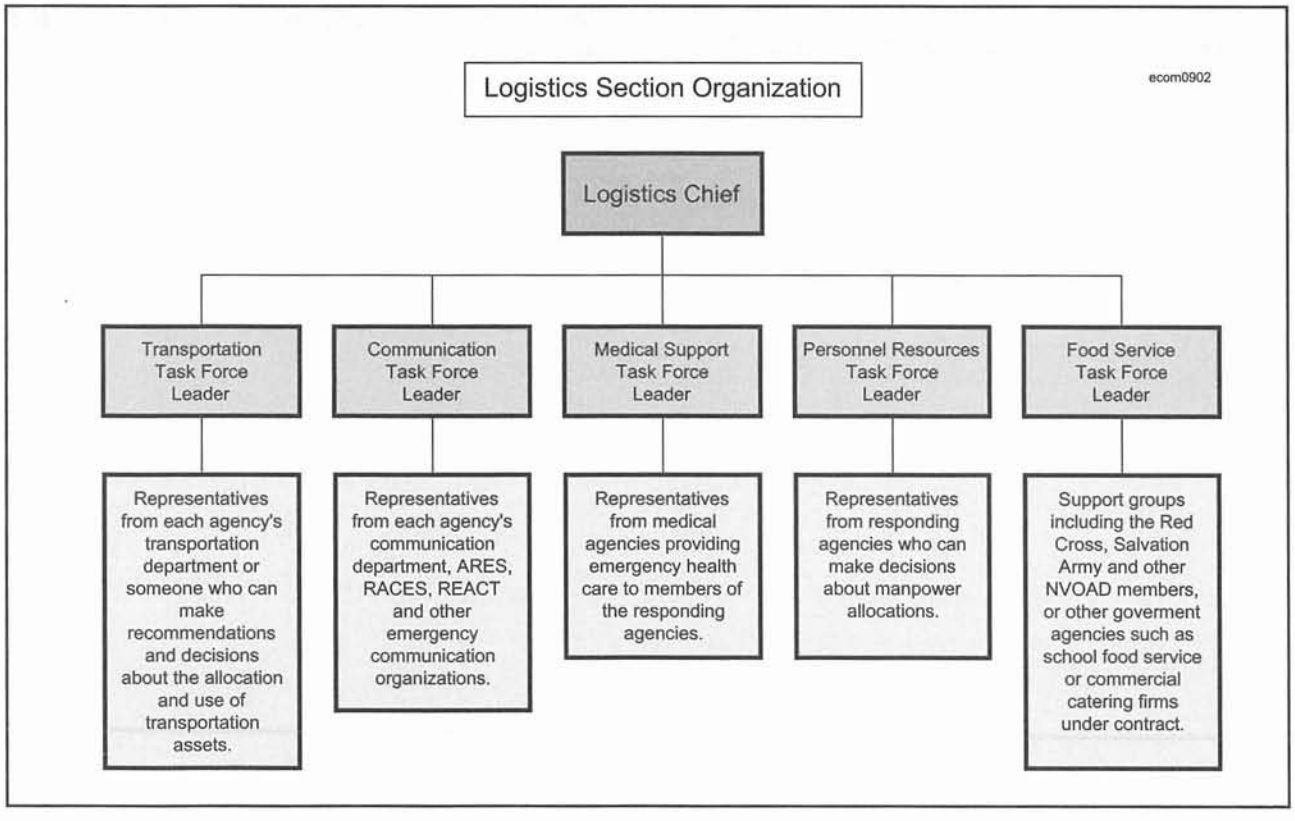
The complexity of the incident will determine how formally the "management by objectives" portion will be handled. If the incident is small and uncomplicated, the process can be handled by verbal communication between appropriate people. As the incident and response become more complex, differences between the individual agencies' or departments' goals, objectives, and methods will need to be resolved in writing.

Organizational structure: The ICS supports the creation of a flexible organizational structure that can be modified to meet changing conditions. Under the ICS, the one person in charge is always called the "Incident Commander" (IC). In large responses, the IC may have a "General Staff" consisting of the Information, Safety and Liaison Officers. In a smaller incident, the IC may also handle one, two or all three of these positions, if they are needed at all.

Various other tasks within the ICS are subdivided into four major operating sections: Planning, Operations, Logistics and Finance/Administration. Each operating section has its own "chief," and may have various "task forces" working on specific goals. The Logistics section handles the coordination of all *interagency* communication infrastructures involved in the response, including Amateur Radio when it is used in that capacity.

These operating sections may be scaled up or down, depending on the needs of the situation. In a small, single agency response, the IC may handle many or all functions. As the size and complexity of a response increase, and as other agencies become involved, the various tasks can be reassigned and sub-divided.

For instance, if the only responding agency is the fire department, communications will be handled according to existing department policies. If the incident expands, more agencies become



Logistic section organization.

involved, and other communication assets are required, a Logistics Chief may handle communication decisions along with other tasks, or assign the job to a "communication task force leader" as his own workload increases.

The Incident Commander: The initial IC is usually the most senior on-scene officer from the first responding agency. The IC is responsible for the management of the incident and starts the process by helping setting initial incident objectives, followed by an "Incident Plan" (IP). In a small incident, the IC may do all the ICS functions without aid, but in a larger incident, they will usually delegate responsibilities to others. The IC still has overall responsibility for the incident, regardless of any duties delegated.

The persons filling certain ICS positions may change several times during an incident as the needs of the response change. For instance, in the early stages of a hazardous materials spill, the Incident Commander may be a fire department officer. As the Coast Guard or other federal agency arrives to begin cleanup efforts, one of their officers will become the Incident Commander.

How Does An Emcomm Group "Fit Into" The ICS

Involvement in any incident where ICS is used is by "invitation only"—there is no role for off-the-street volunteers. The relationship of an emcomm group to the ICS structure will vary with the specific situation. If your group is providing internal communication support to only one responding agency, and has no need to communicate with other agencies that are part of the ICS, you may not have any part in the ICS structure itself except through your served agency. If your group is tasked with handling inter-agency communications, or serves more than one agency's internal communication needs, it is likely your group will have a representative on the Logistics Section's "communication task force."

In certain situations, an emcomm group might serve one or more agencies simultaneously. As the responsibility for managing the incident shifts from one agency to another, the emcomm group's mission may shift to assisting the new lead agency, or simply end. In some cases, your group might begin by supporting your own served agency, and end up supporting a new and unfamiliar agency. The choice of whether to use your emcomm group's services may be made by the served agency, Communications Task Force leader, Logistics Chief, or Incident Commander, depending on the specific situation and the degree of ICS structure in use.

CHAPTER TEN

Preparing for Deployment

Remember the Boy Scout motto, "Be Prepared"? Nearly one hundred years ago, a young British Boy Scout asked Sir Robert Baden-Powell, the founder of Scouting, what exactly it was he should be prepared for. B-Ps famous answer was, "Why, for any old thing, of course!"

The same should be true of emcomm volunteers. You never know which challenges an emergency situation will offer. You might have ac power, or just the batteries you bring along. Safe drinking water may be available, or you may have only your canteen. Sometimes you can find out in advance what sort of conditions are likely for your assignment, but many times no one will know—particularly during the early stages of an emergency.

Being prepared for an emergency communication deployment involves a wide range of considerations, including radio equipment, power sources, clothing and personal gear, food and water, information, and specialized training. No two deployments are the same, and each region offers its own specific challenges. What is appropriate for rural Minnesota in January probably won't work for urban southern California in any season.

Jump Kits

The last thing you should need to do when a call for assistance comes is think of and locate all the items you might need. Any experienced emergency responder knows how important it is to keep a kit of the items they need ready to go at a moment's notice. This is often called a "jump kit" or "go kit."

Without a jump kit, you will almost certainly leave something important at home, or bring items that will not do the job. Gathering and packing your equipment at the last moment also wastes precious time. It is important to think through each probable deployment ahead of time, and the range of situations you might encounter. Here are a few basic questions you will need to answer:

Which networks will you need to join, and which equipment will you need to do so?

Will you need to be able to relocate quickly, or can you bring a ton of gear?

Will you be on foot, or near your vehicle?

Is your assignment at a fixed location or will you be mobile?

How long might you be deployed—less than 48 hours, up to 72 hours, or even a week or more?

Will you be in a building with reliable power and working toilets, or in a tent away from civilization?

What sort of weather or other conditions might be encountered?

Where will food and water come from? Are sanitary facilities available?

Will there be a place to sleep?

Do you need to plan for a wide variety of possible scenarios, or only a few?

Can some items do "double duty" to save space and weight?

Other questions may occur to you based on your

own experience. If you are new to emcomm or the area, consult with other members of your group for their suggestions.

Most people seem to divide jump kits into two categories: one for deployments under 24 hours, and one for up to 72 hours. For deployments longer than 72 hours, many people will just add more of the items that they will use up, such as clothing, food, water and batteries. Others may add a greater range of communication options and backup equipment as well.

Jump Kit Idea List

• Something to put it in—one or more backpacks, suitcases, plastic storage tubs, etc.

• Package individual items in zip lock bags or plastic kitchen containers

Radios and Accessories

• Hand-held VHF or dual-band radio (some people also like to bring a spare)

• Spare rechargeable batteries for handhelds

• Alkaline battery pack for handhelds

• Alkaline batteries

• Speaker mic and earphone for handhelds

• Battery chargers, ac and dc for handhelds

• Mobile VHF or dual-band radio

• HF radio

• Multi-band HF antenna, tuner, heavy parachute cord or nylon mason's twine

• VHF/UHF gain antennas and adapters (roll-up J-Pole, mobile magnetic mount, etc)

• Coaxial feed lines, jumpers

• Ground rod, pipe clamp and wire

• Ac power supplies for VHF/UHF mobile and HF radios, accessories

• Large battery source for VHF/UHF mobile and HF radios, with charger

• All related power, data, audio and RF cables and adapters

• Small repair kit: hand tools, multi-meter, connectors, adapters, fuses, key parts

• Materials for improvisation: wire, connectors, small parts, insulators, duct tape, etc.

• Photocopies of manuals for all equipment

• Headphones, for noisy areas and privacy with proper connector, adaptors

• Specialized gear for packet, ATV or other modes

• Multi-band scanner, weather radio

• Personal cell phone, pager, spare batteries and chargers

• Pencils, legal pads, pencil sharpener

Personal Gear

• Clothing for the season, weather, and length of deployment

• Toilet kit: soap, razor, deodorant, comb, toilet paper

• Foul weather or protective gear, warm coats, hats, etc. as needed

• Sleeping bag, closed-cell foam pad, pillow, earplugs

• High-energy snacks

• Easily prepared dried foods that will store for long periods

• Eating and cooking equipment if needed

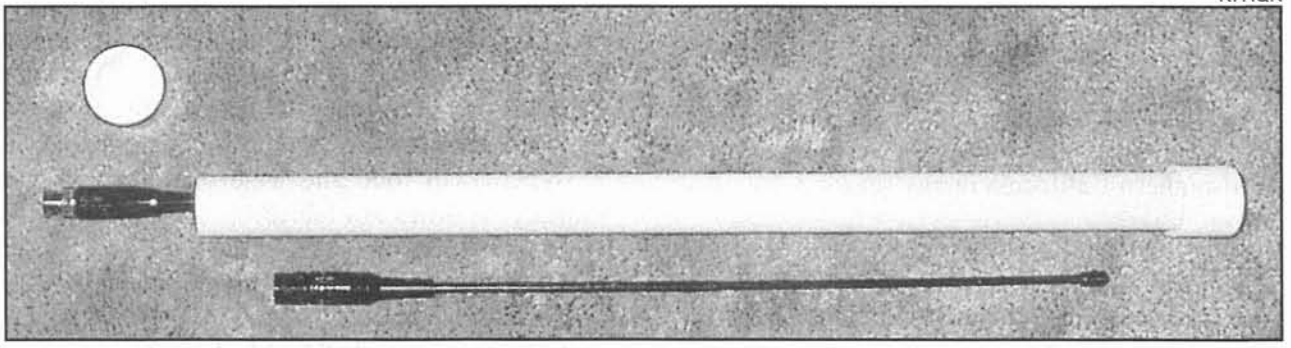
• Water containers, filled before departure

• First aid kit, personal medications and prescriptions for up to one week

• Money, including a large quantity of quarters for vending machines, tolls, etc.

• Telephone calling card

K7RQN



Robert Fairfield, K7RQN, of Peoria, Arizona, found that PVC pipes are practical storage contains for those extra antennas for handhelds. He uses them to transport extra antennas as part of his emergency communication jump kit.

Make sure your jump kit includes a wide range of supplies from sanitary items to snacks.

Information

- ID cards and other authorizations
- Copy of Amateur Radio license
- Frequency lists and net schedules
- Maps, both street and topographic
- Key phone numbers, e-mail and Internet addresses
- Contact information for other members in your group, EC, DEC, SEC and others
- Copy of emergency plans
- Resource lists: who to call for which kinds of problems
- Log sheets, message forms
- Operating Supplies
- Preprinted message forms
- Log sheets or books
- Standard forms used by the served agency
- Letter or legal size notepads
- Sticky notes
- Paper clips and rubber bands
- Blank envelopes
- Stapler, spare staples

Sub-Dividing Your Kits

You may want to divide your jump kit into smaller packages. Here are some ideas:

- Quick deployment kit: hand-held radio kit, personal essentials, in a large daypack
- VHF/UHF, HF kits for fixed locations
- Accessory and tool kit
- Emergency power kit
- Short and long term personal kits in duffel bags
- Field kitchen and food box in plastic storage tubs
- Field shelter kit (tents, tarps, tables, chairs, battery/gas lights) in plastic storage tubs

You may not want to pre-pack some items for reasons of expense or shelf life. Keep a checklist of these items in your jump kit so that you will remember to add them at the last minute.

Pre-Planning

When the time comes, you need to know where to go, and what to do. Having this information

readily available will help you respond more quickly and effectively. It will not always be possible to know these things in advance, particularly if you do not have a specific assignment. Answering the following basic questions may help.

Which frequency should you check in on initially? Is there a "backup" frequency?

If a repeater is out of service, which simplex frequency is used for the net?

Which nets will be activated first?

Should you report to a pre-determined location or will your assignment be made as needed?

Learn about any place to which you may be deployed to familiarize yourself with its resources, requirements and limitations. For instance, if you are assigned to a particular shelter, you might ask your emcomm superiors to schedule a visit, or talk to others who are familiar with the site.

Will you need a long antenna cable to get from your operating position to the roof?

Are antennas or cables permanently installed, or will you need to bring your own?

Will you be in one room with everyone else, or in a separate room?

Is there dependable emergency power to circuits at possible operating positions?

Does the building have an independent and dependable water supply?

Is there good cell phone or beeper coverage inside the building?

Can you reach local repeaters reliably with only a rubber duck antenna, or do you need an antenna with gain?

If the repeaters are out of service, how far can you reach on a simplex channel?

Will you need an HF radio to reach the net?

If you will be assigned to an EOC, school, hospital or other facility with its own radio system in place, learn under what conditions you will be required or able to use it, where it is and how it works. In addition to radios, consider copiers, computers, fax machines, phone systems and other potentially useful equipment.

Consider escape routes. If you could be in the path of a storm surge or other dangerous condition, know all the possible routes out of the area. If you will be stationed in a large building such as a school or hospital, find the fire exits, and learn which parking areas will be the safest for your vehicle.

Training & Education

If the served agency offers emcomm volunteers job-specific training in areas related to communication, take it. Your emcomm managers should help you to learn how the served agency's organization works. Learn their needs and how you can best meet them. Work within your own emcomm organization to get any additional training or information you might need.

For instance, The American Red Cross offers self-study or classroom courses in mass care, damage assessment and other areas that either directly involve or depend upon effective communication. Many emergency management agencies offer additional training in areas such as radiological monitoring, sheltering, mass casualty response and evacuation. The Federal Emergency Management Agency's Emergency Management Institute (**training.fema.gov/EMIWeb/IS/**) offers a wide range of courses, some of which may be related to your agency's mission.

Your own group may offer general or agency-specific training in message handling and net operations under emergency conditions. If your group has its own equipment, it should offer opportunities for members to become familiar with its setup and operation in the field. On your own, set up and test your personal equipment under field conditions to be sure it works as expected.

Participate in any drills or exercises offered in your area. Some are designed to introduce or test specific skills or systems, others to test the entire response. ARRL's Field Day and Simulated Emergency Test are two good nation-wide examples, but local organizations may have their own as well.

CHAPTER ELEVEN

Equipment Choices for Emergency Communications

Transceivers

VHF/UHF: The most universal choice for emcomm is a dual band FM 35-50 watt mobile transceiver. Radios in this class are usually rugged and reliable, and can operate at reasonably high duty cycles, although an external cooling fan is always a good idea if one is not built-in. Handheld transceivers should be used only when extreme portability is needed, such as when "shadowing" an official, or when adequate battery or other dc power is not available. Handheld radios should not be relied upon to operate with a high duty cycle at maximum power, since they can overheat and fail.

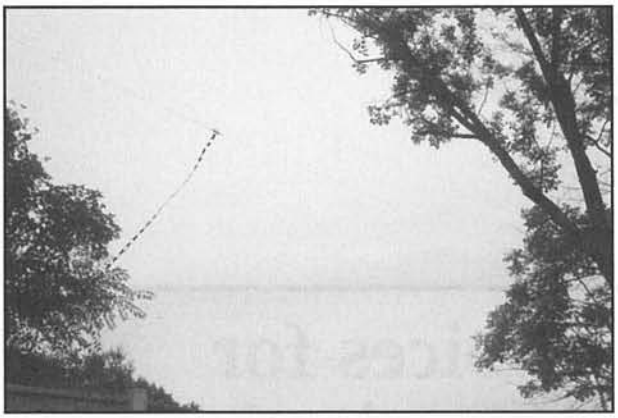
Both portable and mobile dual-band radios can be used to monitor more than one net, and some models allow simultaneous reception on more than one frequency on the *same* band (sometimes known as "dual watch" capability). Some mobiles have separate external speaker outputs for each band. For high traffic locations, such as a Net Control or Emergency Operations Center, a separate radio for each net is a better choice since it allows both to be used simultaneously by different operators. (Antennas must be adequately separated to avoid "de-sensing.")

Many dual-band transceivers also offer a "cross-band repeater" function, useful for linking local portables with distant repeaters, or as a quickly deployable hilltop repeater. True repeater operation is only possible if all other mobile and portable stations have true dual-band radios. Some so-called "dual" or "twin" band radios do not allow simultaneous or cross-band operation—read the specifications carefully before you purchase one.

HF: Operation from a generator equipped Emergency Operations Center can be done with an ac powered radio, but having both ac and dc capability ensures the ability to operate under all conditions. Most 12-V HF radios fall in either the 100-watt or QRP (less than 5 watts) categories. Unless power consumption is extremely important, 100-watt variable output radios should be used. This gives you the ability to overcome noise at the receiving station by using high power, or to turn it down to conserve battery power when necessary.

Do not use dc to ac inverters to power HF radios. Most use a high-frequency conversion process that generates significant broad-spectrum RF noise at HF frequencies that is difficult to suppress. Direct dc powering is more efficient in any case.

Radio Receiver Performance: For radios on all bands, several aspects of a radio receiver's performance can affect its suitability for emcomm. These include sensitivity (ability to receive weak signals), selectivity (ability to reject signals on adjacent frequencies) and intermodulation rejection (ability to prevent undesired signals from mixing within the receiver and causing interference). If you are inexperienced at comparing radio specifications, be sure to ask for guidance from another, more



A basic HF dipole antenna fed with ladder line and matched with an antenna tuner is easily transportable and can be set up quickly.

experienced, ham. An in-depth discussion of radio performance specifications is beyond the scope of this book.

When operating near public service and business radio transmitters, a FM receiver's "intermodulation rejection" is important. Mobile radios generally have better intermodulation rejection than handheld radios, but you should review each individual radio's specifications. External intermodulation (band pass) filters are available, but they add to the expense, complexity, size and weight of the equipment. Bandpass filters will also prevent you from using a broadband radio to monitor public service frequencies. Some older "ham bands only" FM mobile radios have better front-end filtering than newer radios with broadband receive capability, making them more immune to intermodulation and adjacent channel interference.

Receiver filters are important for effective HF operation. Choose appropriate filters for the types of operations you are most likely to use, including CW, RTTY and phone.

Digital Signal Processing (DSP) may be the single most important filtering feature available. Internal or external DSP circuits can allow clear reception of signals that might not otherwise be possible in situations with heavy interference.

"Noise blankers" are used to reduce impulse noise from arcing power lines, vehicle and generator ignition systems, and various other sources. While most all HF radios have some form of noise blanker, some work better than others. Test your radio in suitably noisy environments before designating it for emcomm use.

Antennas

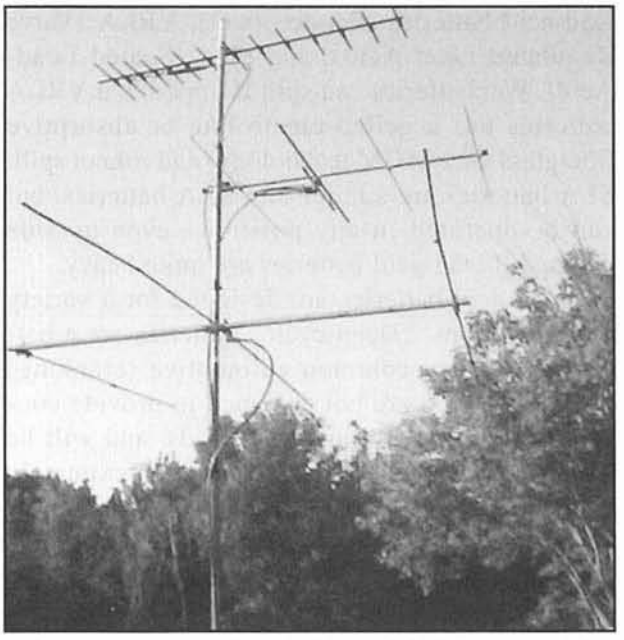
VHF/UHF: A good antenna, mounted as high as possible, is more important than high transmitter power. Not only does it provide gain to both the transmitter and receiver, but a higher gain antenna may also allow output power to be reduced, thus prolonging battery life. In relatively flat terrain, use a mast-mounted single or dual-band antenna with at least 3 dBd gain. If you are operating in a valley, the low angle of radiation offered by a gain antenna may actually make it difficult to get a signal out of the valley. Low or "unity" gain antennas have "fatter" radiation lobes and are better suited for this purpose. Unity gain J-poles are rugged, inexpensive and easily built. For directional 2 meter coverage with about 7-dBd gain, a three or four element Yagi can be used. Collapsible and compact antennas of this type are readily available. For permanent base station installations, consider a more rugged commercial 2-way collinear antenna, such as the well-known "Stationmaster" series. Most 2 meter versions will also perform well on 70cm. Commercial open dipole array antennas will work well for a single band, and are more rugged than a fiberglass radome encased collinear antenna.

A magnetic mount mobile antenna is useful for operating in someone else's vehicle. They can also be used indoors by sticking them to any steel surface, such as filing cabinets, beams or ductwork, even up-side down.

Hand-held radio antennas, known as "rubber duckies," have *negative* gain. Use at least a 1/4 wave flexible antenna for most operations, and consider a telescoping 5/8-wave antenna for long-range use in open areas where the extra length and lack of flexibility will not be a problem. "Roll-up J-pole" antennas made from 300 ohm television twin-lead wire can be tacked up on a wall or hoisted into a tree with heavy-duty string. In addition to unity gain, the extra height can make a big difference. Even a mobile ½ wave magnetic mount antenna can be used with hand-helds when necessary.

HF: There is no single perfect antenna for HF operation. Your choice depends on the size and terrain of the area you need to cover, and the conditions under which you must install and use it.

For local operations (up to a few hundred miles), a simple random wire or dipole hung at a



A stack of Yagi antennas like these can be set up quickly for reliable VHF/UHF communication.

less than ¼ wavelength above the ground works well and is easy to deploy. This is known as a "Near Vertical Incidence Skywave" (NVIS) antenna. The signal is reflected almost straight up, then bounces off the ionosphere directly back downward. NVIS propagation works best on 40 meters during the day, switching to 80 meters around sunset. The new 60-meter band is also ideal for NVIS operation.

An antenna tuner is necessary for most portable wire antennas, (especially for NVIS antennas), and is a good idea for any HF antenna. The antenna's impedance will vary with its height above ground and proximity to nearby objects, which can be a real problem with expedient installations. An automatic tuner is desirable, since it is faster and easier to use, and many modern radios have one built in. Include a ground rod, clamps and cable in your kit since almost all radios and tuners require a proper ground in order to work efficiently.

For communication beyond 200 miles, a commercial trapped vertical may work, although it has no ability to reject interfering signals from other directions. Mobile whip antennas will also work, but with greatly reduced efficiency. The benefits of a mobile antenna are its size and durability.

Directional (beam) antennas offer the best performance for very wide area nets on 10 to 20 meters, since they maximize desired signals and reduce interference from stations in other directions. This ability may be critical in poor conditions. Beam antennas also have a number of limitations that should be considered. They are usually expensive, large, and difficult to store and transport. In field installations, they can be difficult to erect at the optimum height, and may not survive storm conditions. One strategy is to rely on easily installed and repaired wire dipole antennas until conditions allow the safe installation of beam antennas.

Feedline: Feedline used at VHF and UHF should be low-loss foam dielectric coaxial cable. For short runs, RG-58 may be suitable, but for longer runs consider RG-8X or RG-213. RG-8X is an "in-between" size that offers less loss and greater power handling capability than RG-58 with far less bulk than RG-213. If you with to carry only one type of cable, RG-8X is the best choice.

On HF, the choice between coaxial cable and commercial (insulated—not bare wire) "ladder" line will depend on your situation. Ladder line offers somewhat lower loss but more care must be taken in it's routing, especially in proximity to metal objects, or where people might touch it. Coaxial cable is much less susceptible to problems induced by routing near metal objects or other cables.

Operating Accessories

Headphones are useful anywhere, and are mandatory in many locations. Operators in an Emergency Operations Center or a Command Post where multiple radios are in use *must* use headsets. They are also beneficial in locations such as Red Cross shelters, to avoid disturbing residents and other volunteers trying to get some rest.

Some radios and accessory headsets provide a VOX (voice operated transmit) capability. During emcomm operations this should always be turned off and manual "push-to-talk" buttons used instead. Accidental transmissions caused by background noise and conversations can interrupt critical communications on the net.

As an alternative to VOX, consider using a desk or boom microphone and foot switch to key the transmitter. A microphone/headset combination and foot switch also works well.

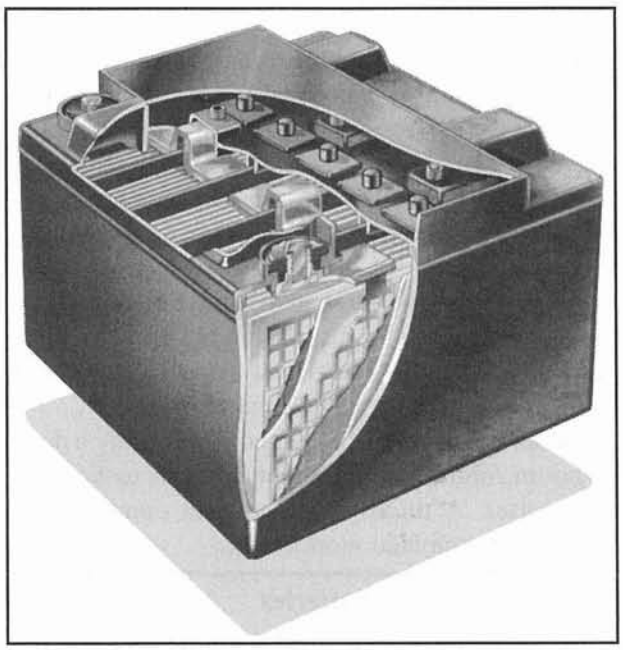
Batteries

Battery power is critical for emcomm operations. Ac power cannot usually be relied upon for

any purpose, and portable operation for extended periods is common. Batteries must be chosen to match the maximum load of the equipment, and the length of time that operation must continue before they can be recharged.

NiCd, NiMH and LIon: For handheld transceivers, the internal battery type is determined by the manufacturer. NiMH batteries store somewhat more energy than NiCd batteries for their size. Many smaller radios are using Lithium Ion (LIon) batteries, which have much higher power densities, without the so-called "memory effect" of NiCds. Many handhelds have optional AA alkaline battery cases, and are recommended emcomm accessories. Common alkaline batteries have a somewhat higher power density than NiCd batteries, are readily available in most stores and may be all you have if you cannot recharge your other batteries. Most handheld radios will accept an external 13.8Vdc power connection for cigarette lighter or external battery use. External batteries of any type can be used with a handheld, as long as the voltage and polarity are observed. Small 12-15 volt gel cells and some battery packs intended for power tools and camcorders are all possibilities. For maximum flexibility, build a dc power cable for each of your radios, with suitable adapters for each battery type you might use.

Lead Acid: There are three common types of lead-acid batteries: flooded (wet), VRLA (Valve Regulated Lead Acid), and SLA (Sealed Lead-Acid). Wet batteries can spill if tipped, but VRLA batteries use a gelled electrolyte or absorptive fiberglass matt (AGM technology) and cannot spill. SLA batteries are similar to VRLA batteries, but can be operated in any position—even up-side down. All lead-acid batteries are quite heavy.



Cutaway diagram of a lead acid battery.

Lead acid batteries are designed for a variety of applications. "Deep-cycle" batteries are a better choice than common automotive (cranking) batteries, which are not designed to provide consistent power for prolonged periods, and will be damaged if allowed to drop below approximately 80% of their rated voltage. Deep cycle batteries are designed for specific applications and vary slightly in performance characteristics. For radio operation, the best choice would be one specified for UPS (uninterruptible power source) or recreational vehicle (RV) use. For lighting and other needs, a marine type battery works well. For best results, consult the manufacturer before making a purchase.

Sealed lead acid (SLA) or "gel cells," such as those used in alarm or emergency lighting systems, are available in smaller sizes that are somewhat lighter. These batteries are also the ones sold in a variety of portable power kits for Amateur Radio and consumer use. Typical small sizes are 2, 4, and 7Ah (amp/hours), but many sizes of up to more than 100Ah are available. SLA batteries should never be deeply discharged. For example, a 12 volt SLA battery will be damaged if allowed to drop below 10.5 volts. Excessive heat or cold can damage SLA batteries. Storage and operating temperatures in excess of 75 degrees F or below 32 degrees F will reduce the battery's life by half. Your car's trunk is not a good place to store them. Storage temperatures between 40 and 60 degrees will provide maximum battery life.

Battery "Power Budgeting": The number of amp/hours required, called a "power budget," can be roughly estimated by multiplying the radio's receive current by the number of hours of operation, and then adding the product of the transmit current multiplied by the estimated number of hours of transmission. For a busy net control station, the transmit current will be the determining factor because of the high duty cycle. For low activity stations, the receiver current will dominate. The value obtained from this calculation is only a

rough estimate of the ampere/hours required. The Ah rating of the actual battery or combination of batteries should be up to 50% higher, due to variations in battery capacity and age.

Estimated 24-hour power budget example

Receive current: 1 amp x 24 hours = 24 Ah

Transmit current: 8 amps x 6 hours = 48 Ah (25% transmit duty cycle)

Total Ah: 72 Ah estimated actual consumption

Actual battery choice 72 × 1.5 = 108 Ah

Chargers, Generators and Solar Power

Battery Chargers: You should have two or more batteries so that one can be charging while another is in use.

NiCd and NiMH batteries: The type of charger required depends on the battery—for instance, most NiCd chargers will also charge NiMH, but not LIon batteries. Several aftermarket "universal" chargers are available that can charge almost any battery available. A rapid-rate charger can ensure that you always have a fresh battery without waiting, although rapid charging can shorten a battery's overall lifespan.

Lead-acid batteries: Always consult the battery's manufacturer for precise charging and maintenance instructions, as they can vary somewhat from battery to battery. It is best to slow-charge all batteries, since this helps avoid overheating and extends their over-all life span. In general, automotive and deep cycle batteries can be charged with an automobile and jumper cables, an automotive battery charger, or any constant-voltage source. If a proper battery charger is not available, any dc power supply of suitable voltage can be used, but a heavy-duty isolation diode must be connected between the power supply and the battery. (This is important, since some power supplies have a "crowbar" overvoltage circuit, which short-circuits the output if the voltage exceeds a certain limit. If a battery is connected, the crowbar could "short-circuit" the battery with disastrous results.) The output voltage of the supply must be increased to compensate for the diode's voltage drop. Take a measurement at the battery to be sure. Wet batteries should be charged at about 14.5 volts, and VRLA batteries at about 14.0 volts. The charging current should not exceed 20% of the battery's capacity. For example, a 20-amp charger is the largest that should be used for a battery rated at approximately 100 Ah. Consult the battery's manufacturer for the optimum charging voltage and current whenever possible.

Deep cycle batteries do not normally require special charging procedures. However, manufacturers do recommend that you use a charger designed specifically for deep cycle batteries to get the best results and ensure long life.

SLA or "gel- cell" batteries must be charged slowly and carefully to avoid damage. All batteries produce hydrogen sulfide gas while recharging. Non-sealed batteries vent it out. SLA batteries do what is called "gas recombination." This means that the gas generated is "recombined" into the cells. SLA batteries actually operate under pressure, about 3 psi. for most. If the battery is charged too quickly, the battery generates gas faster then it can recombine it and the battery over-pressurizes. This causes it to overheat, swell up, and vent, and can be dangerous and will permanently damage the battery.

The charging voltage must be kept between 13.8 and 14.5 volts. A good rule of thumb is to keep the charging current level to no more than $^1/_3$ its rated capacity. For example, if you have a 7Ah battery, you should charge it at no more than 2 amps. The time it takes for a SLA battery to recharge completely will depend on the amount of charge remaining in the battery. If the battery is only 25% discharged then it may recharge in a few hours. If the battery is discharged 50% or more, 18-24 hours may be required.

Solar panels and charge controllers are readily available at increasingly lower costs. These provide yet another option for powering equipment in the field when weather and site conditions permit their use. When choosing solar equipment, consult with the vendor regarding the required size of panels and controller for your specific application.

Dc to ac inverters. While direct dc power is more efficient and should be used whenever possible, inverters can be used for equipment that cannot be directly powered with 12Vdc.

Not all inverters are suitable for use with radios, computers or certain types of battery chargers. The best inverters are those with a "true sine-wave" output. Inverters with a "modified sine-wave" output may not operate certain small battery chargers, and other waveform-sensitive equipment. In addition, all "high-frequency conversion" invert-

ers generate significant RF noise if they are not filtered, both radiated and on the ac output. Test your inverter with your radios, power supplies and accessories (even those operating nearby on dc) and at varying loads before relying upon it for emcomm use. Effective filtering for VHF and UHF can be added rather simply (using capacitors on the dc input, and ferrite donuts on the ac output), but reducing HF noise is far more difficult. Inverters should be grounded when in operation, both for safety and to reduce radiated RF noise.

As an alternative to an inverter, consider a mid-sized 12V computer UPS (uninterruptible power source). Smaller, square-wave UPS units are not designed for continuous duty applications, but larger true sine-wave units are. Most true sine-wave units use internal batteries, but with minor modifications can be used with external batteries. The larger commercial UPS units run on 24 or 48 volts, and require two or four external batteries in series. UPS units will have a limit on the number of depleted batteries they can re-charge, but there is no limit to the number of batteries that can be attached to extend operating time.

Generators are usually required at command posts and shelters for lighting, food preparation and other equipment. Radio equipment can be operated from the same or a separate generator, but be sure that co-located multiple generators are bonded with a common ground system for safety. Not all generators have adequate voltage regulation, and shared generators can have widely varying loads to contend with. You should perform a test for regulation using a high-current power tool or similar rugged device before connecting sensitive equipment. A voltmeter should be part of your equipment any time auxiliary power sources are used.

Gasoline-powered generators can be excellent emergency power sources, although they tend to be noisy.

Noise levels can be a concern with generators. Some are excessively noisy and can make radio operations difficult and increase fatigue. A noisy generator at a shelter can make it difficult for occupants to rest, and can result in increased levels of stress for already stressed people. Unfortunately, quieter generators also tend to be considerably more expensive. Consider other options such as placing the generator at a greater distance and using heavier power cables to compensate. Placing a generator far from a building can also prevent fumes from entering the building and causing carbon monoxide poisoning, an all-too-common problem with emergency generators.

Several other devices may be helpful when dealing with generators or unstable ac power sources. High quality surge suppressors, line voltage regulators and power conditioners may help protect your equipment from defective generators. Variable voltage transformers ("Variacs") can be useful to compensate for varying power conditions.

Equipment For Other Modes

If you plan to operate one of the digital modes (packet, APRS, PACTOR, PSK31, etc), then you will also need a computer and probably a TNC or computer sound card interface. Some newer radios have built-in TNCs. Be sure to identify all the accessories, including software and cables, needed for each mode. Include the power required to operate all of the radios and accessories when you are choosing your batteries and power supply. The internal battery in your laptop computer will probably not last long enough for you to complete your shift. Be prepared with an external dc power supply and cable, or a dc to ac inverter. If you need hard copy, then you will also need a printer, most of which are ac powered.

Scanners and Other Useful Equipment

In addition to your Amateur Radio equipment, you may find a few other items useful.

Multi-band scanning radio (to monitor public service and media channels)

FRS, GMRS or MURS hand-helds

Cellular telephone (even an unregistered phone can be used to call 911)

Portable cassette tape recorder with VOX (for logging, recording important events)

AM/FM radio (to monitor media reports)

Portable television (to monitor media reports)

Weather Alert radio with "SAME" feature (to provide specific alerts without having to monitor the channel continuously)

Laptop computer with logging or emcomm-specific software

Testing The Complete Station

After making your equipment selection (or beforehand if possible), field test it under simulated disaster conditions. This is the fundamental purpose of the annual ARRL Field Day exercise in June, but any time will do. Operations such as Field Day can add the element of multiple, simultaneous operations on several bands and modes over an extended period. Try to test all elements of your system together, from power sources to antennas, and try as many variations as possible. For instance, use the generator, then switch to batteries. Try charging batteries from the solar panels and the generator. Use the NVIS antenna while operating from batteries and then generator. This procedure will help reveal any interactions or interference between equipment and allow you to deal with them now—before proper operation becomes a matter of life and death.

CHAPTER TWELVE

Emergency Activation

To begin with, you must be registered with a local emcomm group in advance in order to be on their notification list. "Last minute" volunteers are extremely difficult to integrate into an already confusing emergency response. Join the group well in advance of any emergency, get any training they offer, and be ready when a call comes.

Every emcomm group should have developed a formal, written plan with its served agency to activate their members when needed. The plan should be developed in detail, and then reduced to a simple "checklist" that both served agency officials and emcomm managers can keep nearby at all times. It should detail the circumstances under which emcomm activation might occur, who will call whom, and the various methods that can be used to contact them. The checklist can also list the actual telephone numbers and other contact information for each individual listed in the order that it is to be used. This information should be verified and updated on a regular schedule. Each member should know the plan and follow it closely.

Initial Notification by the Served Agency

In most cases, three or more members serve as "activation liaisons" to the served agency. When the emcomm volunteers are needed, it is one of these members who is called first. Never rely on a single point of contact. If that person is unavailable for any reason, the served agency should have one or more alternatives to try. They may be called by phone at work or at home, but the most reliable primary method is commercial radio paging (beepers). In the event that the paging system or an individual pager is not operating, the served agency should have all possible telephone numbers, including fax and mobile, and even e-mail addresses.

Group Alerting Systems

Once a liaison has been notified, a number of group alerting methods may be used. The most common ones are described below. No one method should be relied upon, since emergency conditions may render it useless. Commercial paging systems and ham repeaters might be off the air, phone lines down, and Internet service disrupted. Again, a written plan and checklist should be developed well in advance, and updated periodically.

***Telephone Tree*:** In this system, the liaison calls two members, who each call two other members and so on until the entire group has been notified. If any one person cannot be reached, the person calling must then call the members that person would have called had they been reached. This method insures that the "tree" is not broken. Messages should always be left on all answering machines and voice mailboxes.

Paging: If commercial digital pagers are used,

the liaison or someone he designates calls each member's pager telephone number and sends a specific numeric emcomm activation code. The code might indicate the six-digit frequency of a local repeater, followed by a three-digit "action" code (e.g.: 911 for an emergency, 000 for test). Some groups use a two-tone, POCSAG (digital), or similar paging signal on a local Amateur repeater with wide coverage, activating commercial voice or digital pagers that have been modified to monitor the repeater's frequency.

A low-cost method of "paging" a group using an Amateur repeater uses a specific Continuous Tone Coded Squelch System (CTCSS) tone. Members leave their radios turned on in the "CTCSS decode" mode when they are not actively listening to the repeater. When the correct CTCSS tone is turned on for emcomm activation, everyone can hear the transmissions. Since many newer radios include CTCSS decoding as a standard feature or low-cost option, this method is generally simple to implement. The tones may need to be generated by the repeater itself, since many repeaters will not "pass through" received tones. If the repeater is not operating, a mobile operating simplex on the repeater's output frequency from a high or central location can often work quite well.

E-mail: While e-mail might not immediately reach members anywhere they happen to be, it is a good backup method as long as it continues to function. Many people have full time high-speed Internet connections at home and the office, and most people check their e-mail frequently. Someone who has otherwise been unreachable may check their e-mail even several hours later, just as they might check an answering machine or voicemail box.

Self-Activation: If you become aware of an incident or situation that might require the activation of your emcomm group, you should take immediate steps to make yourself available. Depending on your group's activation plan, this might mean monitoring the assigned net or served agency frequencies, or making contact with one or more appropriate persons in the emcomm group or served agency. SKYWARN members might also monitor National Weather Radio. Remember, if you are not specifically authorized to directly contact served agency personnel, do not do it. Know your plan and follow it.

I Have Been Notified—Now What?

Your group's activation plan should tell each member what steps to take immediately after learning of emcomm activation. In most cases, the first step should be to check in on a specific frequency or repeater. If a repeater is used as the primary gathering point for members, a back-up simplex frequency (the repeater's output frequency works well) should be specified in the event that the repeater is no longer operating. In other cases, some members may also have specific assignments. These might include making contact with the served agency, going directly to a specific location such as an EOC, or making certain preparations. These members should quickly check into the "activation" net to let emcomm managers know that they have been reached and are responding.

One of the liaison stations should be available on the net to provide additional information from the served agency and directions to members as they check in. If a member is pre-assigned to act as NCS for the "activation" net, that person should take over the task as soon as possible to free up the liaison to work with the served agency or take other action. Some groups simply have the first person signing on act as a temporary NCS until an

A search-and-rescue team in action.

assigned NCS checks in. Again, it is important to have more than one person assigned to take on the NCS duties in the event that anyone is unavailable.

En Route

While you are headed home to pick up your jump kit or other gear, or while you are on your assigned location, there are several things you may need to do. Check into and continue to monitor the activation net for further information or instructions. Fill your vehicle with fuel and pick up any supplies you may need, including alkaline batteries for radios and lights, food, water, and other supplies on your checklist. Contact your spouse, children or other family members to let them know what is happening and where you will be. Give them any instructions they will need to be safe. Tell them when you will next try to contact them, and how to contact you if necessary. Knowing that everyone is OK can let you do your job without needless worry, and, of course, the same is true for them.

CHAPTER THIRTEEN

Setup, Initial Operations and Shutdown

If you already have your assignment, confirm that it is being activated by monitoring and checking into the local activation net. If you do not have a standing assignment, you should check into an activation net and make yourself available for an assignment. It might be a "resource" logistics net if one is active, or the general "tactical" command activation net. (Since local procedures vary widely, you should get to know your group's specific plans and procedures well in advance.)

After you have gathered your equipment and supplies, filled the gas tank and are ready to respond, you may need to do several things, depending on local plans and the nature of the emergency. You may be asked to check in to a specific net to let them know you are en route, and then periodically to report your progress, particularly if travel is hazardous.

In some cases, you may be asked to proceed to a "staging" or "volunteer intake" area to wait for an assignment. This could take some time, especially if the situation is very confused. Often, the development of the response to the emergency is unclear and it will take some time to develop a cohesive and uniform response plan for that incident. You should expect the situation to be fluid as each incident is unique and to respond accordingly. Be prepared to wait patiently for a determination to be made and an assignment to be given.

In other cases, such as the immediate aftermath of a tornado or earthquake, you may be forced to make expedient arrangements as you go. Travel may be difficult or impossible, so you may need to do what you can, where you can. Nets may be established on an ad-hoc basis using whatever means are available.

Who Is In Charge?

At each station, the EC or other emcomm manager should appoint one member of the emcomm group to take a leadership role as "station manager," with full responsibility for all operations at that site. This person serves as a point of contact, information and decisions for the team with the incident commander and with other groups aiding in the response. This helps avoid confusion and arguments.

When you accept a position as an emcomm volunteer, you do so knowing that you will often need to follow the directions of another person. Cooperation and good teamwork are key elements that result in an efficient and effective emcomm operation. As the situation arises, you may have to step into a role of a leader to keep the operation moving forward.

Expect to work with others. Expect that there are times when you are the follower. Expect that at other times, you may be the leader.

Arriving at the Site

If you are assigned to a facility operated by the served agency, such as a shelter, introduce your-

Flood disasters require emcomm deployment over wide areas.

self to the person in charge as an "emergency communicator" assigned to serve that location. They will be busy, so get right to the point:

Identify yourself and explain that you have been assigned to set up a communication station for that location, and by whom.

Inform them that you would like to set up your equipment and get on the air. Ask if another communicator has already arrived. Ask if they have a preference for the station's location and explain your needs.

If you are the first communicator to arrive, be prepared to suggest an appropriate location—one that can serve as both an operating and message desk, has feed line access to a suitable antenna location, access to power and telephone, and is just isolated enough from the command center to avoid disturbing each other.

Ask if there are any hazards or considerations in the immediate area that you should be aware of, or that may cause you to relocate later.

If no building or other suitable shelter is available, you may need to set up your own tent, or work from your car. Choose a location that provides shelter from wind, precipitation and other hazards, and is close enough to the served agency's operations to be convenient, but not in each other's way.

Being a Good Guest

In many cases, you will be occupying a space that is normally used by someone else for another purpose. Respect and protect their belongings and equipment in every way possible. For instance, if you are in a school and will be using a teacher's desk, find a way to remove all the items from its surface to a safe place for the duration of operations. A cardboard box, sealed and placed under the desk usually works well. Do not use their office supplies or equipment, or enter desk drawers or other storage areas without specific permission from a representative of the building's owners. Some served agencies will seal all filing cabinets, drawers and doors to certain rooms with tamper-evident tape upon arrival to protect the host's property and records.

When installing antennas, equipment and cables, take care not to damage anything. For instance, avoid using "duct" tape to fasten cables to walls or ceilings, since its removal will usually damage the surface. If damage is caused for any reason, make note of it in your log and report it to the appropriate person as soon as possible.

Initial Setup And Information Gathering

In most cases, your first priority will be to set up a basic station to establish contact with the net. Pack that equipment in your vehicle last so that you can get to it first. If you arrive as a team of two or more, station setup can begin while others carry in the remaining equipment.

Set up and test the antenna for proper SWR, and then check into the net. Test to find the lowest power setting that produces reliable communication, especially if you are operating with battery or generator power, to conserve power for extended operations. High power should also be avoided whenever lower power will work just as well to prevent interference with other radio systems, telephones and electronic equipment.

Once your basic station is on the air, you can begin to work on other needs:

- Check for working telephones, faxes, Internet and other means of communications
- Learn about the served agency's operations and immediate needs at that site
- Install additional stations or support equipment
- Make a list of stations within simplex range
- Identify possible alternative message paths
- Find sanitary facilities
- Determine water and food sources, and eating arrangements
- Review overall conditions at the site, and how they will affect your operations
- Find a place to get some occasional rest

As soon as possible, ask a member of the served agency's staff to spend a few moments to discuss the agency's operational needs. What are the most critical needs? Whom do they need to communicate with, and what sort of information will need to be transmitted? Will most messages be short and tactical in nature, or consist of long lists? Will any messages be too confidential for radio? Are phones and faxes still working? What will traffic needs be at different times of day? How long is the site anticipated to be open? Will there be periodic changes in key agency staff?

You may also need to provide agency staff with some basic information on how to create a message. Show them how to use message forms and instruct them on basic procedures to follow. Be sure to let them know that their communications will not be private and "secure" if sent by Amateur Radio, and discuss possible alternatives.

Ending Operations

Emcomm operations may end all at once, or be phased out over time. Several factors may affect which operations end, and when:

Damaged communication systems are restored and returned to service

Traffic loads are reduced and can be handled with normal systems

Shelters and other locations are closed

How you are notified to end operations will depend on the policies of your emcomm group and served agency, and the specific situation. For instance, even though a shelter manager has been told to shut down by the served agency, your orders may normally come from a different person who may not be immediately aware of the shelter's closing. In this case, you might need to check with the appropriate emcomm manager before closing your station. Once the decision to close your station has been received and verified, be sure that the person in charge of the location is aware that you are doing so, and if necessary, why.

File and package all messages, logs and other paperwork for travel. Return any borrowed equipment or materials. Carefully remove all antennas and equipment, taking care to package and store it correctly and safely. Avoid the temptation to toss everything into a box with the intention to "sort it out later," unless you are under pressure to leave in a hurry. In the event you are re-deployed quickly, this will save time in the end.

Departure

Several actions may be necessary when leaving. First, be sure to leave the space you used in as good a condition as possible. Clean up any messes, remove trash and put any furniture or equipment back where it was when you arrived. If you sealed desktop items in a box for safekeeping, simply place the box on the cleaned desk. Do not unpack the items and attempt to replace them on the desk. This will provide proof to the desk's owner that you took steps to protect their belongings, and helps keep them secure until their owner takes possession again. Do not remove

tamper evident tape or similar seals placed by others unless told to do so by the appropriate person, or in accordance with the agency's policy.

Thank all those who worked with you. Even a simple verbal "thanks" goes a long way, compared to hearing not a single word. Do not forget the building's owners or staff, the served agency staff or others you worked with, and any other emcomm personnel. This is also the time for any apologies. If things did not always go well, or if any damage was caused, do your best to repair the relationship before departing. These simple efforts can go a long way toward protecting relationships between all groups and individuals involved.

The Debriefing

After each operation, your emcomm group, and perhaps even the served agency, will probably want to hold a meeting to review the effectiveness of the operation. There may be issues that occurred during operations that you will want to discuss at this meeting. Events may have occurred within the served agency that involved communications you handled. If you try to rely entirely on your memory or logbooks, you will probably forget key details or even forget certain events altogether.

To prevent this from happening, keep a separate "de-briefing" diary, specifically for use during this meeting. Some entries might only refer briefly to specific times and dates in the station operating log, or they may contain details of an issue that are not appropriate in the station log. If you will be required to turn over your station logs immediately at the end of operations, your de-briefing diary will need to contain full details of all events and issues for discussion.

Such information might include:

- What was accomplished?
- Is anything still pending? Note unfinished items for follow-up.
- What worked well? Keep track of things that worked in your favor.
- What needed improvement?
- Ideas to solve known problems in the future.
- Key events
- Conflicts and resolutions

During the de-briefing, organize the session into (a) what worked well, and (b) what could be improved for the next operation. Change criticisms and judgment statements into a constructive manner by saying, "This method might have worked better if..." rather than "This method was stupid." Also, avoid personal attacks and finger pointing. In most cases, interpersonal issues are dealt with most effectively away from the group meeting.

CHAPTER FOURTEEN

Operations and Logistics

Unlike commercial and public safety radio users, Amateurs have a vast amount of radio spectrum to use in meeting the needs of an emergency. Most local and regional emcomm communication takes place on 2 meter or 70 centimeter FM, or on 40, 60 or 80 meter SSB/CW. The choice made is based on the locations to be covered, the availability of repeaters, distance, terrain, and band conditions.

VHF and UHF FM are preferred for most local operations because the equipment is common, portable, has a clear voice quality and the coverage is extended by repeater stations. VHF and UHF communication range is determined by terrain, antenna height and the availability of repeaters.

For larger areas or in areas without repeaters, HF SSB may be needed. Most local emcomm operation is on the 40 or 80-meter bands using Near Vertical Incidence Skywave (NVIS) propagation. For long-haul communication needs and international operations, 15 or 20-meter nets may be the best option.

Many emcomm groups will have pre-selected a number of frequencies for specific purposes. The complete list of these frequencies should be in your jump kit, and pre-programmed into your radios.

Know Your Resources In Advance

Become familiar with the coverage and features of each permanent repeater and digital message system in your area, and pre-program your radios with the frequencies, offsets and CTCSS tones. Ask your EC or AEC which repeaters are used for emergency communication in your area. Will they be available for exclusive emcomm use, or must they be shared with other users? Information to find out includes:

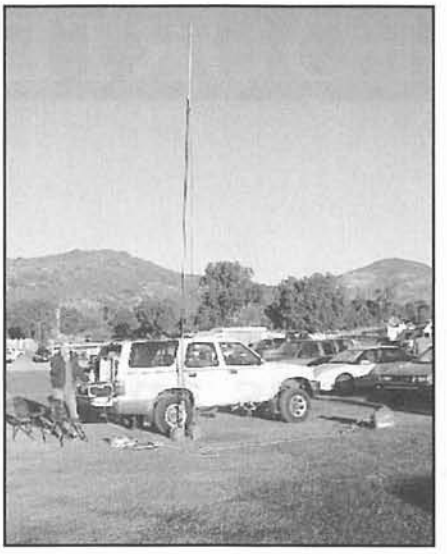
- How does the repeater identify itself?
- Are there any "dead spots" in critical areas? How much power is required to reach the repeater with a clear, quiet, signal from key locations?
- Does the repeater have a courtesy tone, and what does it sound like? Do the tones change depending on the repeater's mode?
- How long is the "time-out timer"?
- Is it part of a linked system of repeaters? What features does it have, and which touch-tone commands or CTCSS tones activate them?

For net frequencies that support digital communication systems, such as packet radio bulletin board messaging systems, PACTOR, PSK31 and RTTY:

- Which software do they use? *ARESPACK*, *Fnpack*, *FNpsk*?
- Do the digital systems have mailboxes or digipeater functions?
- Which other nodes can they connect to? Can traffic be passed over an Internet link automatically or manually?
- How many connections can they support at once?

Network Coverage Concerns

Most emcomm managers rely on simplex operation when planning their VHF or UHF FM nets for one reason: repeaters often do not survive disasters or are overwhelmed with the amount of traffic. Repeaters that do survive and are usable are considered a bonus. Since simplex range is limited by terrain, output power, antenna gain and height, operation over a wide area can be a challenge. Almost any structure or hills can block signals to some degree.



W6GMQ and N6QKE set up a portable emergency communications station on a soccer field during the 2004 San Diego County fires.

To avoid last minute surprises, your group should pretest all known fixed locations in your area for coverage. For instance, if you are serving the Red Cross, test simplex coverage from each official shelter to the Red Cross office and the city's EOC or other key locations, and mobile coverage in the same areas. If needed, there are several ways to improve simplex range:

Use an antenna with greater gain
Move the antenna away from obstructions
Use a directional antenna
Increase antenna height
Increase transmitter output power as a last resort.

In a fast moving situation with poor simplex coverage and no repeater, it can be helpful to place a mobile station on a hilltop or office building where they can communicate with, and relay for, any station in the net. A mobile relay station can also allow communications to follow a moving event, such a wildfire or flash flood. That station becomes, in effect, a "human repeater." Although an expedient "work-around," this slow and cumbersome process can reduce net efficiency by more than half. A modern aid to this kind of operation is the "simplex repeater." This device automatically records a transmission, and immediately re-transmits it on the same frequency. Remember that FCC rules do not allow unattended operation of simplex repeaters, and that you must manually identify it.

A better solution is a portable duplex repeater that can be quickly deployed at a high point in the desired coverage area. The coverage of this repeater does not have to be as good as a permanent repeater—it just has to reach and hear the stations in your net. Portable repeaters have been used successfully from the back seat of a car, using a mobile antenna, and parked on a ridge or even the top floor of a parking garage. Portable masts and trailer-mounted towers have also been used successfully.

If all stations in the net have dual-band radios or scanners, a strategically located mobile radio may be operated in "cross-band repeater" mode. If you use your dual-band mobile in this manner for an extended period, use the low or medium power setting to avoid overheating and damaging your radio. Consider using a fan to further reduce the likelihood that your radio will be damaged from overheating.

For a permanent repeater to be useful in a disaster, it must have emergency power, and be in a location and of such construction that it can survive the disaster. Agreements with repeater owners should be in place to allow emergency operations to the exclusion of regular users.

Frequency and Net Resource Management

While we may have a large amount of frequency resources, in actual practice our choices are limited to the available operators and their equipment. Net managers may occasionally need to "shift" resources to meet changing needs. In the early stages of an emergency, the tactical nets may require more operators, but in later stages, the health and welfare traffic might increase.

In addition to the main net frequency, each net should have several alternate frequencies available. These should include one or more "back up" frequencies for use in the event of interference, and one or two frequencies to be used to pass traffic "off net."

Message Relays

When one station cannot hear another, a third station may have to relay the messages. Although this is a slow and cumbersome process, it is often

the only way to reach certain stations. If relays must be used, move the stations involved off the main net frequency to avoid tying up the channel for an extended period.

Radio Room Security

To protect your equipment and the messages you handle, and prevent unnecessary distractions, it is best to allow only the operators who are on duty to be in the room. Avoid leaving the radio room and equipment unattended and accessible. It is never a good idea to allow members of the press to be in the room without specific permission from the served agency.

Record Keeping

Most served agencies will expect you to keep records of your operations. These records will certainly include original copies of any messages sent, station logs, memos, and official correspondence. Some may even require you to keep "scratch" notes and informal logs. Depending on agency policy, you may be required to keep these records in your own possession for a time, or to turn some or all records over to the agency at the end of operations. In some agencies, your station records are permanent and important legal documents, and must be treated as such. It is important to know your served agency's policy on record keeping in advance so that you can comply from the very beginning of operations.

Your station operating logs should probably contain the following information:

- Your arrival and departure times
- Times you check in and out of specific nets
- Each message, by number, sender, addressee and other handling stations
- Critical events—damage, power loss, injuries, earth tremors, other emergencies
- Staff changes—both emcomm and site management, if known
- Equipment problems and issues

Every individual message or note should be labeled with a time and date. In the case of scratch notes, place dates and times next to each note on a sheet, so that information can be use later to determine a course of events.

If you expect to operate from the location for more than a day or two, establish a message filing system so that you can retrieve the messages as needed. A "portable office" type file box, expanding file or any other suitable container can be used to organize and file the messages. This is also an efficient way to allow another operator to pick up where you left off, even if they arrive after you leave. Effective record keeping allows them to come up to speed quickly.

Dealing With Stress and Egos

Any unusual situation can create personal stress—disasters create incredible amounts of it. Most people are not used to working under extreme stress for long periods, and do not know how to handle it. They can become disoriented, confused, unable to make good decisions or any decisions at all, lose their tempers, and behave in ways they never would at any other time. Nervous breakdowns are common among those who get overwhelmed and have not learned to manage stress and stress-causing situations.

Especially in the early hours of a disaster, the tendency is to regard every situation or need as an "emergency," requiring an immediate response. You might get a barrage of requests for action. You might not have the extra seconds it requires to fully consider the options, and to prioritize your actions. The result is an overload of responsibility, which can lead to unmanageable levels of stress.

While you cannot eliminate disaster-related stress, you can certainly take steps to reduce or control it. Here are some tips to help you manage the situation to avoid creating, and deal with, excessive stress and stressful situations:

- Delegate some of your responsibilities to others. Take on those tasks only you can handle.
- Prioritize your actions—the most important and time-sensitive ones come first.
- Do not take comments personally. Mentally translate personal attacks into constructive criticism—and a signal that there may be an important need that is being overlooked.
- Take a few deep breaths and relax. Do this often, especially if you feel stress increasing. Gather your thoughts, and move on.
- Watch out for your own needs—food, rest, water, medical attention.
- Do not insist on working more than your assigned shift if others can take over. Get rest when you can so that you will be ready to handle your job more effectively later on.
- Take a moment to think before responding to

a stress-causing challenge. If needed, tell them you will be back to them in a few minutes.

• If you are losing control of a situation, bring someone else in to assist or notify a superior. Do not let a problem get out of hand before asking for help.

• Keep an eye on other team members, and help them reduce stress when possible.

Some within the emergency response community have big egos, and still others with a need to be in full control at all times. Both personality types can be problematic anytime, but far worse under stress. Take time now to consider how you will respond to the challenges they present. If your automatic response to certain behaviors is anger, make a conscious decision to come up with a different and more positive response strategy. Depending on the official position of the problem person, you might:

• Do your job as best you can, and deal with it after the emergency is over

• Politely decline and state your reasons

• Refer the issue to a superior

• Choose in advance to volunteer in another capacity and avoid that person altogether

Long Term Operations

As soon as it becomes clear that the situation is not going to return to normal for a while, you and your group should make plans for extended emcomm operations. Hopefully, your emcomm group and served agency have prepared contingency plans for this, and all you will have to do is put them into action. If not, here are some potential needs to consider:

• Additional operators to allow for regular shift changes, and to replace those who go home

• Replacement equipment (as operators leave with their own gear or it fails)

• Food and water

• A suitable place to sleep or rest

• Generator fuel

• Fresh batteries

• Sanitation facilities

• Shelter

• Message handling supplies, forms

• Alternate NCS operators, backups

• Additional net resources to handle message traffic

Battery Management

If you are operating on battery power, you will eventually need to recharge your batteries. As discussed earlier, some batteries need more time to recharge than others, and this time needs to be taken into account in your planning. Deep cycle marine batteries, for instance, can require a full day or longer to fully recharge. Sealed lead-acid (SLA) batteries, also known as "gel-cells," require up to 18 hours to recharge depending on the size of the battery. NiCd, LIon and similar batteries can be recharged quite quickly, although repeated rapid charge cycles can reduce overall battery life.

If you are using slow-charging batteries, you may need to have enough on-hand to last the entire length of the operation. If your batteries can be charged quickly, some means must be provided for doing so. Some chargers can be powered from a vehicle's 12-volt system, and are a good choice for emcomm. If no local means of charging is available, your logistics team may need to shuttle batteries back and forth between your position and a location with power and chargers.

Generator and Power Safety

Take some care in the placement of generators so that they will not be a problem for others. Engine noise can make it difficult for shelter residents and volunteers to get much needed rest, and for anyone trying to do their job. Exhaust fumes should not be allowed to enter the building or nearby tents or vehicles. A position down-wind of any occupied location is best. Even when vehicles are not included, internal combustion engines are still the number one cause of carbon monoxide poisoning in the United States. Propane powered engines produce as much or more CO as gasoline or diesel engines.

Earth grounding of portable or vehicle-mounted ac generators is not required as long as only plug and cord connected equipment is used, and the generator meets National Electrical Code (NEC) standards listed in Article 250-6. The main exception is for generators that will be connected, even temporarily, to a building's permanent electrical system. For further details on grounding ac electrical systems, please refer to Article 250 of the NEC.

Ground Fault Interrupters (GFIs) add a further degree of safety when working with generators and portable power systems. GFIs detect any difference between the currents flowing on the hot and neutral conductors, and open the circuit. Also,

be sure to test any GFI device to be used with or near HF radios to be sure that the GFI will function properly while the radio is transmitting.

Ac extension cords used to connect to generators or other power sources should be rated for the actual load. Consider radios, lights, chargers and other accessories when calculating the total load. Most extension cords are rated only for their actual length, and cannot be strung together to make a longer cord without "de-rating" the cord's capacity. For example, a typical 16 gauge, 50 foot orange "hardware store" cord is rated for 10 amps. When two are used to run 100 feet, the rating drops to only 7 amps. Choose a single length of cord rated for the load and the entire distance you must run it. If this is not possible, you can also run two or more parallel cords to the generator in order to reduce the load on any single cord. For more information on portable power cord requirements, consult Article 400 of the NEC.

While some groups have used Romex type wire for long extension cords, this is actually a violation of the National Electrical Code, and a dangerous practice. Repeated bending, rolling and abrasion can cause the solid copper conductors and insulation to break, resulting in a fire and electrocution hazard. Use only flexible insulated extension cords that are UL rated for temporary, portable use.

Equipment—Leaving Yours Behind?

You are exhausted, and ready to head for home, but the emcomm operation is far from over. You brought along a complete station, and when you leave, the next operator is not nearly as well equipped. Should you leave your equipment behind for the next operator?

You have several options here—and they are all yours to choose from. No one can, or should, tell you to leave your equipment behind. If you feel comfortable that someone you know and trust will look after your gear, you may choose to leave some or all of it behind. If you do, be sure every piece is marked with at least your name and call sign. Do not leave behind anything the next operator does not truly need. Also, remember that even if you leave the equipment in the possession of someone you know, you still have the ultimate responsibility for its operation and safety. Emergency stations are difficult places to control and monitor. If your equipment is stolen, lost or damaged, you should not hold anyone responsible but yourself. Conversely, if someone leaves their equipment in your care, treat and protect it better than you would your own, and be sure it is returned safely to its owner.

Accepting Specialized Assignments

In the world of modern emcomm, you may be asked to handle other assignments for the served agency that may or may not include communicating. At one time, most emcomm groups had strict policies against doing other tasks, and this is still true of some. In the days when radios were difficult to operate under field conditions and required constant attention, this was important. The other common reason given is that you have volunteered to be a communicator, not a "bed pan changer." It is true that some agency's staff will abuse the situation when they are short of help, but if both the agency's staff and emcomm group are clear about any limits beforehand, the problem should not arise.

Today, most emcomm groups will permit their members to be cross-trained for, and perform, a variety of served-agency skills that *also include communicating*. Examples are SKYWARN weather spotting, Red Cross damage assessment and many logistics jobs. If your group still has a "communication only" policy, are you really meeting your agency's needs? Is it necessary to have a damage assessment person *and* a communicator to do that job? What would happen to your agency if each driver also had to bring along a dedicated radio operator? Can one person do both jobs?

CHAPTER FIFTEEN

Personal Safety, Survival and Health

Disaster relief volunteers sometimes become so involved with helping others that they forget to take care of their own families and themselves. The needs of disaster victims seem so large when compared with their own that volunteers can feel guilty taking even a moment for their own basic personal needs. However, if you are to continue to assist others, you need to keep yourself in good condition. If you do not, you risk becoming part of the problem. If your family is not safe and all their needs are not taken care of, worrying about them may prevent you from concentrating on your job.

Home and Family First

Before leaving on an assignment, be sure you have made all necessary arrangements for the security, safety and general well being of your home and family. Family members, and perhaps friends or neighbors, should know where you are going, when you plan to return, and a way to get a message to you in an emergency.

If you live in the disaster area or in the potential path of a storm, consider moving your family to a safe location before beginning your volunteer duties. Take whatever steps you can to protect your own property from damage or looting, and let a neighbor or even local police know where you are going, when you plan to return, and how to reach you or your family members in an emergency.

In addition to your emcomm deployment checklists, you might want to create a home and family checklist. It should cover all their needs while you are gone. Here are some ideas to get you started:

House

- Board up windows if you are in a storm's path
- Put lawn furniture and loose objects indoors if high winds are likely
- Move valuables from lower to upper levels if flooding is possible
- Heating oil tanks should be filled
- Drain pipes if below-freezing temperatures and power loss are possible
- Shut off power and gas if practical and if structural damage is possible

Family

- A safe place to stay if needed, preferably with friends or relatives
- Reliable transportation, with fuel tank filled
- Adequate cash money for regular needs and emergencies (not ATM or credit cards)
- House, auto, life and health insurance information to take along if evacuated
- Access to important legal documents such as wills, property deeds, etc.
- Emergency food and water supply
- AM/FM radio and extra batteries

- Flashlight and extra batteries, bulbs
- Generator, fuel and safe operating knowledge
- Adequate supply of prescription medications on hand
- List of emergency phone numbers
- Pet supplies and arrangements (shelters will not take pets)
- List of people to call for assistance
- Maps and emergency escape routes
- A way to contact each other
- A plan for reuniting later

Should You Leave At All?

There are times when your family may need you as much or more than your emcomm group. Obviously, this is a decision that only you and your family can make. If a family member is ill, your spouse is unsure of their ability to cope without you, if evacuation will be difficult, or any similar concern arises, staying with them may be a better choice. If there is ever any doubt, your decision must be to stay with your family. This is also something you should discuss, and come to an agreement with your spouse about well before any disaster, in order to avoid any last minute problems.

You First—The Mission Second

Once you are working with your emcomm group, you will need to continue to take care of yourself. If you become over-tired, ill or weak, you cannot do your job properly. If you do not take care of personal cleanliness, you could become unpleasant to be around. Whenever possible, each station should have at least two operators on duty so that one can take a break for sleep, food and personal hygiene. If that is not possible, work out a schedule with the emcomm managers or your NCS to take periodic off-duty breaks.

Food

Most people need at least 2000 calories a day to function well. In a stressful situation, or one with a great deal of physical activity you may need even more. Experienced emcomm managers and served agency personnel will usually be aware of this issue and take steps to see that their volunteer's needs are met. If you are at a regular shelter, at least some of your food needs may be taken care of. In other situations, you may be on your own, at least for a while. High calorie and high protein snacks will help keep you going, but you will also need food that is more substantial. You may need to bring along some freeze-dried camping food, a small pot, and a camp stove with fuel, or some self-heating military-style Meals, Ready to Eat (MRE) packages.

Water

Safe water supplies can be difficult to find during and after many disasters. You will need at least two or three liters of water each day just for drinking, more for other purposes. In extremely hot or cold conditions, or with increased physical activity, your needs will increase significantly. Most disaster preparedness checklists suggest at least one gallon per person, per day.

Many camping supply stores offer a range of water filters and purification tablets that can help make local water supplies safer. However, they all have limitations you should be aware of. Filters may or may not remove all potentially harmful organisms or discoloration, depending on the type. Those with smaller filter pores (.3 microns is a very tight filter) will remove more foreign matter, but will also clog more quickly. Iodine-saturated filters will kill or remove most harmful germs and bacteria, but are more expensive and impart a faint taste of iodine to the water. Most filters will remove Giardia cysts. All water filters require care in their use to avoid cross-contamination of purified water with dirty water.

Purification tablets, such as Halazone, have a limited shelf life that varies with the type, and give the water an unpleasant taste. Tablets will do nothing for particulate (dirt) or discoloration in the water. Be sure to read and understand the information that comes with any water purification device or tablet before purchasing or using it.

The FDA says you can use plain Clorox brand laundry bleach (no perfumes, etc). After filtering out any particulate by pouring it through several layers of densely woven cloth, put sixteen drops of Clorox in a gallon of water, mix well, and allow it to sit for thirty minutes. If it still smells slightly of chlorine, you can use it. If not, stir in sixteen more drops and wait another half hour. If it still does not smell of chlorine, discard the water and find a new supply. It will not taste great, nor will the chlorine bleach kill cysts like Giardia, but it may be enough.

If you have no other means, boiling for at least five minutes will kill any bacteria and other organisms, but will not remove any particulate matter or discoloration. Boiling will leave water with a "flat" taste that can be improved by pouring it back and forth between two containers several

times to reintroduce some oxygen.

Sleep

Try to get at least six continuous hours of sleep in every twenty-four hour period, or four continuous hours and several shorter naps. Bring fresh soft foam earplugs and a black eye mask to ensure that light and noise around you are not a problem. An appropriate sleeping bag, closed-cell foam pad or air mattress, and your own pillow will help give you the best chance of getting adequate rest. If caffeine keeps you awake, try to stop drinking coffee, tea, or other beverages containing caffeine at least four hours before going to bed. Allowing yourself to become over-tired can also make falling asleep difficult.

Personal Hygiene

If you pack only a few personal items, be sure they include toothpaste and toothbrush, a comb, and deodorant. If possible, bring a bar of soap or waterless hand cleaner, a small towel and washcloth, and a few extra shirts. Waterless shampoo is available from many camping stores. After two or three days without bathing, you can become rather unpleasant to be around. Think of others and make an attempt to stay as clean and well-groomed as you can under the circumstances.

Safety in an Unsafe Situation

Many disaster assignments are in unsafe places. Natural disasters can bring flying or falling debris, high or fast moving water, fire, explosions, building collapse, polluted water, disease, toxic chemicals, and a variety of other dangers. You should always be aware of your surroundings and the dangers they hold. Never place yourself in a position where you might be trapped, injured or killed. Try to anticipate what might happen and plan ahead. Always have an escape plan ready in the event that conditions suddenly become dangerous. Do not allow yourself to become "cornered"—always have more than one escape route from buildings and hazardous areas.

Wear appropriate clothing. Depending on the weather, your gear might include a hard hat, rain gear, warm non-cotton layers, work gloves and waterproof boots. Always bring several pairs of non-cotton socks and change them often to keep your feet clean and dry. Create seasonal clothing lists suitable for your climate and the types of disasters you might encounter. As a volunteer communicator, you will not generally be expected to enter environments that require specialized protective clothing or equipment. Do not worry about purchasing these items unless required by your served agency.

Avoid potentially dangerous areas. Industrial buildings or facilities may contain toxic chemicals, which can be released in a disaster. Dams can break, bridges can wash out and buildings can collapse. Areas can become inaccessible due to flooding, landslides, collapsed structures, advancing fires or storm surges. If you can avoid being in harm's way, you can also prevent yourself from becoming part of the problem rather than part of the solution.

Be prepared to help others find or rescue you should you become trapped or isolated. Carry a police or signal whistle and a chemical light stick or small flashlight in your pocket. Let others know where you are going if you must travel anywhere, even within a "safe" building. Try not to travel alone in dangerous conditions—bring a "buddy."

Shelter

In most cases, you will not need your own shelter for operating or sleeping. You may be able to stay or work in the emergency operations center, evacuation shelter or even your own vehicle. However, in some cases a tent, camp trailer, motor home or other suitable shelter may be necessary. Your choice will depend on your needs and resources.

Tents should be rated for high winds, and should be designed to be waterproof in heavy weather. Most inexpensive family camping tents will not survive difficult conditions. Dome tents will shed wind well, but look for published wind survival ratings since not all dome designs are equal. Your tent should have a full-coverage rain fly rather than a single waterproof fabric. The tent's bottom should be waterproof, extending up the sidewalls at least six inches in a "bath-tub" design, but bring an extra sheet of plastic to line the *inside* just in case. (Placing a plastic ground cloth under a tent will allow rain to quickly run under and through a leaky tent floor.) Bring extra nylon cord and long ground stakes to help secure the tent in windy conditions. If you are not an experienced foul weather camper, consider consulting a reputable local outfitter or camping club for advice on selecting and using a tent.

Medical Considerations

If you have a medical condition that could poten-

tially interfere with your ability to do your job, it is a good idea to discuss this with your physician ahead of time. For instance, if you are a diabetic, you will need to avoid going for long periods without proper food or medication, and stress may affect your blood sugar level. Persons with heart problems may need to avoid stressful situations. Even if your doctor says you can participate safely, be sure you have an adequate supply of appropriate medications on hand, and a copy of any prescriptions. Let your emcomm manager and any work partners know of your condition so that they can take appropriate actions if something goes wrong. Wear any medical ID jewelry you have. Keep a copy of any special medical information and emergency phone numbers in your wallet at all times.

Protect Your Eyes and Sight

If you wear eyeglasses or contact lenses, bring at least one spare pair. If you use disposable contact lenses, bring more than enough changes to avoid running out. Some contact lens wearers may want to switch to glasses to avoid having to deal with lens removal and cleaning under field conditions. If you have any doubts, consult your eye doctor ahead of time. Bringing a copy of your lens prescription along may also be a good idea, especially if you are likely to be some distance from home for a while.

Sunglasses may be a necessity in some situations. Working without them in bright sun can cause fatigue, and possibly eye damage. If you are in an area with large expanses of snow or white sand, prolonged periods of exposure can cause the retina to be burned, a very painful condition commonly known as "snow blindness." Since no painkiller will help with retinal burns, it is best to use good quality UV blocking sunglasses at all times, and avoid prolonged exposure.

If you do not normally wear eyeglasses, consider a pair of industrial safety glasses or goggles to protect your eyes from wind-blown water, dust and debris. Keep all spare eyeglasses or safety glasses/goggles in a felt-lined hard-shell storage case to prevent scratching and breakage.

Sample Personal Survival and Comfort Needs Checklist (Modify according to your own situation)

Suitable size backpack or duffel bag for clothing and personal gear

Plastic storage tub for food, cooking gear

Toilet kit—soap, comb, deodorant, shampoo, toothbrush, toothpaste

Toilet paper in zipper-lock freezer bag

Small towel and washcloth

Lip balm

Facial tissues

Sunscreen

Insect repellent

Prescription medications (1 week supply)

Copies of medication and eyeglass/contact lens prescriptions

Spare eyeglasses or contact lenses and supplies

Hand lotion for dry skin

Small first aid kit

Non-prescription medications, including painkiller, antacids, anti-diarrheal, etc.

Extra basic clothing—shirts, socks, underwear

Gloves, for protection or warmth

Pocket flashlight

Folding pocketknife

Sleeping bag, closed-cell foam pad or air mattress, pillow

Ear plugs (soft foam type in sealed package)

Black eye mask

Outer clothing for season and conditions (rain gear, parka, hat, face mask, etc)

Hardhat

Reflective vest, hat

Travel alarm clock

Chemical light sticks

Police or signal whistle

Dust masks

Phone/e-mail/address list for family, friends, neighbors, physician, pharmacy

Emergency contact/medical information card in your wallet

Spare car and house keys

High energy or high protein snacks

Food—Freeze-dried or MREs

Coffee, tea, drink mixes

Plate or bowl, knife, fork and spoon, insulated mug

Camp stove, small pot, fuel and matches

Battery or other lantern

Water, in heavy plastic jugs

Water purification filter or tablets

Magnetic compass, maps

Duct tape, parachute cord

Consider packing individual items or kits in zipper-lock freezer bags to keep the contents dry, clean and neat.

CHAPTER SIXTEEN

Alternative Communication Methods

Amateur radio may not always be the only or best radio service for the job. Sometimes it is better to hand an official a radio he can use to stay in contact with the ARES team on site, and not saddle him or her with a ham radio "shadow." This is particularly true for officials who must regularly deal with sensitive issues.

Other voluntary agencies may use these radio services in their own operations.

The radio services discussed in this chapter are commonly available at low cost and are in general use. Other volunteers may already own radio equipment in these services, and amateur emergency communication groups should be equipped to communicate with them.

Legal Considerations

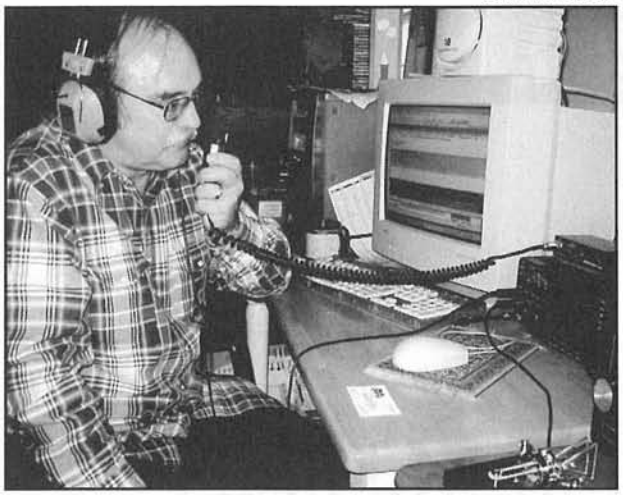
Some radio services require licenses, and others do not. However, in a true emergency *as defined by the FCC*, this may not be a problem. FCC rules gives everyone special permission to use "any means necessary" to communicate in order to protect life and property—*but only when no other normal means of communication is possible*. Please do not assume that this means you can just modify your radio and call for help on the local police frequency the next time you see a car crash on the highway. Law enforcement agencies are not bound by the FCC's rules. Hams who have called for help on police frequencies have been convicted of "interfering with a police agency" under state and local laws, even though the FCC had taken no enforcement action. In one case, the judge ruled that by modifying his radio in advance, the amateur had committed "pre-meditated" interference, a serious charge. If you are in a position to save someone's life or property, be sure you are ready to defend your actions—and possibly lose—before pressing the mic button.

Other services, such as GMRS, require a license that is relatively easy to obtain, although not free. If your group is planning to use licensed radios, obtain your license well before any emergency and keep it current. If you own a radio, but no license, a judge could claim pre-meditation if you use it and disturb licensed users.

Using Modified Ham Radios

While it is easy to modify many VHF and UHF amateur radios for operation in nearby public service and business bands, it is not legal to do so for regular emergency use. Radios used in those bands must be "Type Accepted" by the FCC for the purpose, and amateur radios are not. If you plan to use other radio frequencies discussed in this unit, it is better to purchase the proper radio. However, if the need arises and your ham radio is all you have, the FCC will probably not prosecute you for

SARI KREIGER



John Heartney, KG4NXT, handling emergency traffic during Hurricane Isabel in 2004.

using it—if the use falls within their strict rules for emergencies (see above).

Permissible Modes On The Other Radio Services

In most of the radio services listed below only voice communication is permitted. Packet and other forms of data or image transmission are illegal.

Citizens' Band (CB) Radio

As a widespread system of casual communication, CB radio is still quite popular among the public and truckers. Since the 1950s, CB has been available to anyone for the purpose of short-range business and personal/family communication. No licensing is required, and tactical or self-assigned identifiers are acceptable. A recommended method promoted by the FCC is the letter "K," followed by the user's first and last initials, followed by your zip code. If you had a valid Class D License before the mid 1980s, you may continue to use your old CB call sign. *Do not use your amateur call!*

CB radios operate in the 11-meter band, on forty designated channels from 26.965 to 27.405 MHz, with a maximum output power of four watts. Most use amplitude modulation (AM) but a few also offer single side band (SSB). The effective range between two CB mobile stations averages two to eight miles. Depending on antennas, terrain and propagation, base to mobile communication is possible up to 25 miles. The use of SSB can significantly increase range, but SSB use is not widespread due to the extra cost. FCC rules permit communication to a maximum of 75 miles.

In many remote areas with little or no telephone service, families rely on CB radios for basic day-to-day communications. Many rural police and sheriff's organizations still monitor CB traffic. In a number of states, highway patrol officers install CB units in their patrol cars with the blessing of their agencies. However, many departments that used to monitor channel 9 have given up the practice. REACT groups in the area may still be monitoring.

In disaster situations, great emphasis is placed on the timely movement and distribution of supplies by truck. By far, the largest group of CB users is the trucking community. Channel 19 has been the unofficial trucker channel since the late 1960s, and in some areas is as good as channel 9 when calling for assistance.

Channel 9 is reserved for emergency and motorist assistance traffic only. Aside from REACT, organizations in many parts of the world monitor channel 9 and other designated distress channels. In some countries, Citizens Radio Emergency Service Teams (CREST) teams serve the same functions as REACT.

Multi-Use Radio Service (MURS)

With little fanfare, the FCC added a new, unlicensed citizen's radio service in 2000. Both personal and business operation is permitted, with a maximum power of two watts. The MURS frequencies are 151.820, 151.880, 151.940, 154.570 and 154.600. While base operation is not specifically prohibited at this time, the service is primarily intended for mobile and portable operation.

A Motorola MURS transceiver.

For about 20 years, certain businesses have been able to obtain licenses for operation on what the FCC calls "itinerant" frequencies. These channels became commonly referred to as the

"color dot" channels. (A color dot label on the packaging identifies the frequency of the walkie-talkie.)

One of the former itinerant channels, 154.570 MHz, (blue dot), is now a MURS channel. This means that a number of these low-cost one or two-watt output "itinerant" radios (which are usually user programmable for itinerant channels only) could be utilized for MURS. This allows you to equip unlicensed volunteers with a VHF portable having much the same simplex capability as a 2-meter handheld.

Family Radio Service (FRS)

Almost anywhere, in most every situation, you can find FRS radios in use. Family Radio Service portables are useful, effective and inexpensive. Like CB, the Family Radio Service is designed for short-range personal communications. Campers, hikers, vacationers and families on weekend outings use FRS units to keep in touch.

A Midland hand-held Family Radio Service transceiver.

There are 14 available UHF channels, and 38 different CTCSS codes to limit background chatter and noise. Output power is from 100 to 500 mW, depending on the model.

In an effort to standardize the ability to call for help using FRS, REACT recommends the use of FRS channel 1 (462.5625 MHz) with no CTCSS tone as an emergency calling channel. REACT is also lobbying the manufacturers of FRS equipment to suggest this plan in the user's information packed with new radios. A petition to the FCC requesting that this be made official was denied in late 2001. Monitoring the channel is recommended to all persons in outdoor areas whenever possible.

The first seven FRS channels are shared with the General Mobile Radio Service (GMRS). Although the original rules seem to prohibit it, a later FCC Report and Order explicitly permit communication between the two services. The chance of a distress call being heard on either service is greatly increased on these seven common channels.

Most FRS radios are available with 2 or 14 channels, although single channel radios can be found. It is important to note that the channel numbers on each radio are not always interchangeable between these units. Single channel radios are usually on channel 1, which corresponds to channel 1 in the 14-channel units.

General Mobile Radio Service (GMRS)

The GMRS consists of fifteen UHF frequencies between 462.5625 and 462.7250 MHz. Eight are paired with matching repeater inputs 5 MHz higher, as with amateur and commercial systems. Seven "interstitial" channels are shared with FRS, and operation there is restricted to simplex with a maximum of 5 watts. Power on the other channels is limited to 50 watts. GMRS stations have the option of working only simplex modes if desired, even on paired channels. There is no frequency coordination, and users must cooperate locally to effectively use channels. CTCSS codes are the same as for FRS, and the first 7 channels are common to both services. FM voice operation is permitted, but digital modes and phone patches are not.

Operating a GMRS station will require a low-cost system license from the FCC. You can apply using FCC Form 574, or apply online. FCC online licensing information can be obtained at **www.fcc.gov**. System licenses are currently granted only to individuals. A system includes any and all radios operated by family members, and may include fixed, mobile, and repeater equipment. Use under the license is restricted to members of the licensee's immediate family. Licenses to entities other than individuals are no longer issued, but non-individual entities licensed before July 31, 1987 may continue to renew their licenses, and may not increase or modify their use.

The frequency of 462.675 MHz is recognized for emergency and travel information use, and is monitored by many REACT teams nationwide. Many teams operate repeaters on this and other frequencies.

Current uses for GMRS involve mostly personal and family communications. Hiking, camping and convoy travel are all common GMRS applications. GMRS use for emergency services is limited by the licensing requirements, but could be pressed into service in a disaster situation. One or more

An ICOM marine transceiver.

come licensed if use of GMRS is likely, especially for liaison with locally active REACT teams.

Public Safety Radio

There are instances where the use of police and fire radio frequencies is possible. The agency itself might allow and train you for such use, or an individual officer may ask you to use his radio to call for help when he cannot. Keep your transmissions short and to the point. Do not tie up the channel with long explanations, and cease transmitting if they tell you to.

Cellular and PCS Phones

In a widespread disaster situation, these phone systems can quickly become overloaded. In smaller emergencies, they may still be usable. If a message is too sensitive to send via any two-way radio, try your cell phone. Cellular and PCS phone transmissions, especially digital, are considerably more secure. In addition, it is possible to send low-speed data or fax transmissions over the cellular network.

Marine Radio

FM marine radios operate on internationally allocated channels in the 160 MHz band. HF SSB radios operate on a variety of ITU channels between 2 and 30 MHz. Operation of FM stations for vessels in US waters does not require a license, but operation on the HF channels does. When working in coastal areas, along major rivers or the Great Lakes; it may be a good idea to have a FM marine radio in your group's inventory. During major storms, you can monitor channel 16, the distress channel. If you hear a vessel in distress whose calls are going unanswered by the Coast Guard, you may legally answer them from an unlicensed land-based station under the FCC's emergency communications rules. If the Coast Guard is in communication with the vessel, do not transmit. Most other land-based operation is illegal, except where authorized by an FCC coast station license.

Aviation Radio

AM radios operating in the 108-136 MHz band are used in aircraft and in certain limited vehicles and ground stations. FCC licenses are required for all stations. Emergency locator transmitters (ELTs) are automatic devices that transmit a distress signal on 121.5 and 243.0 MHz. 121.5 is the civilian distress channel, and 243.0 is its military counterpart. These frequencies are also used for marine Emergency Position Indicating Radio Beacons (EPIRB) and the new land-based Personal Radio Beacons (PRB). While it is unlikely that you will ever need to use an aircraft band radio except where it is provided by the served agency, it is good to be familiar with the radio service. Monitoring 121.5 for ELT, EPIRB, and PRB signals and distress calls is always a good idea.

Non-Radio Communication

Do not forget one of the most obvious means of communication—the telephones. If they are still functioning, use the telephone and fax whenever the message might be too sensitive for radio. Fax is also useful for sending long lists, and where accuracy is critical. Do not tie up a radio frequency sending a long list of supplies if a working fax or phone is available.

Couriers

Since before the time of early Greek civilization, runners have carried messages from place to place. When we are asked to deliver a sensitive or very lengthy message, and fax and phone lines are out of service, hand delivery might be the best choice if travel is possible. Acting as a courier does not eliminate the use of radio, since couriers need to be dispatched from place to place. Courier service is actually an excellent marriage of old and new technologies.

CHAPTER SEVENTEEN

What to Expect in Large-Scale Disasters

What happens to critical communication assets during the onset of disaster conditions? First, there is a huge increase in the volume of traffic on public-safety radio channels, accompanied by prolonged waiting periods to gain access. As the disaster widens, equipment outages occur at key locations. Messages are not handled in order of priority, and urgent messages are often lost.

As agencies respond, the need arises for agencies to communicate with one another. Meeting that need is an up-hill battle as these agencies have incompatible radio systems, and use unfamiliar or unattainable frequencies, names, terms and procedures. Exacerbating the situation is the fact that most agencies are reluctant to use another agency's system, or to allow theirs to be used by others.

In a large-scale situation, a need arises to contact locations at distances beyond the range of a given radio or system (50 to 350 miles or more).

Message reply delays are experienced, leading to deferred decisions on crucial matters, message duplication and confusion. A need arises to generate and decipher handwritten messages sent through relaying stations.

Different modes of communication are required in addition to voice:

- Volume data in printed form—data modes, high-speed packet and facsimile.
- Morse code or PSK31 under difficult reception conditions.
- Encoded data for extreme privacy.
- Television—mobile, portable, aeronautical and marine.
- Telephone interconnections from/to radio systems.

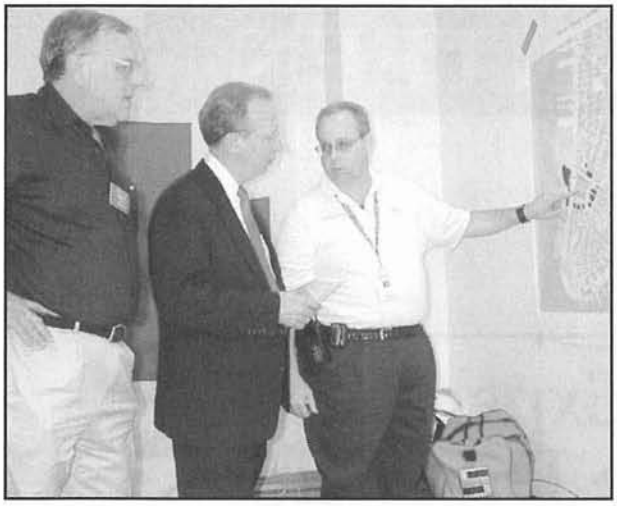
Simultaneously with a high volume of message traffic, stations must cope with messages having widely differing priorities. Also, priority and precedence designations differ among agencies if any are used at all.

Operational problems arise such as:

- High-volume traffic circuits with no supply of message forms.
- Using the only printed forms available that were designed for a different, unrelated agency or function.
- Attempting to decipher scribbling from untrained message writers; using scribes who cannot understand radio parlance or read through QRM.
- Becoming inundated with traffic volume so heavy it results in confusion over which messages are to be sent, which were sent, which have been received for delivery, and which have been received to be filed for ready reference.

What Happens in the First 72 Hours?

In the early hours of an emergency turning into a major disaster, it takes precious time to overcome the obstacles to placing fully activated mutual aid



Hams mobilized immediately following the September 11, 2001 terrorist attacks. In New York, American Red Cross Disaster Telecommunications Staff Partner Jay Ferron, N4GAA (right), points to Ground Zero as ARRL President Jim Haynie, W5JBP (center) and ARRL Hudson Division Director Frank Fallon, N2FF, look on.

Storm surge destroys roads after a hurricane strikes Texas.

resources into operation. Communication is one of those vital resources.

The greatest concentration of relief efforts is generally found in the incorporated cities served by agencies with paid professionals—assuming their equipment, facilities and personnel remain operable. While urban areas experience more concentrated damage, suburbs and isolated areas of a county suffer from remoteness from fire departments, public works, law enforcement and the services of all other agencies. All organizations scramble to respond to an unprecedented demand for service within their authorized jurisdiction.

In these circumstances the public is often isolated, unable to call for help or determine the nature and extent of the disaster so that they can make plans to:

- Wait it out.
- Prepare to evacuate.
- Actually, evacuate with some possessions to a safe place.
- Obtain physical aid for an impending catastrophe.
- Offer aid to a relative, friend or neighbor.

Lack of information results in further attempted use of the telephone when the system is already saturated, if indeed it is still operating at all. Calls can often be received from out-of-town but not made across town.

The opportunity to call for help is often unavailable to most citizens during the first 72 hours. Occasionally, a passing public safety vehicle or one equipped with an operational commercial, utility, amateur or CB radio can be flagged down to make a call—assuming it can contact a person who can help.

Too little information is gathered about the public's immediate needs, and ways to meet them. Distorted public perceptions develop through misinformation. At the same time, essential damage-assessment report data is needed by state and federal agencies to initiate relief aid from outside the disaster area.

Broadcast stations (those still on the air) initially disseminate rumors in the absence of factual information. Those few people who possess an operating battery-powered broadcast band radio can tune until they find a local station that can provide helpful information. Others receive such information second hand, if at all.

Everywhere, people walk aimlessly seeking a route to family and friends. Many, fearful of looting, remain in hazardous buildings, or return, as do shopkeepers, to salvage valuables. As darkness falls, rumors of looting are generated—some true.

Word circulates about shelter locations. Some displaced persons stay at homes of friends, relatives or strangers. Others are housed at public shelters into the fourth day, still searching for family members elsewhere, and without communication. The opportunity to notify concerned distant relatives is not afforded except via Amateur Radio and the American Red Cross.

Later, often too late, information trickles in

about problem areas or cases that have been overlooked due to the lack of communication. Some potential evacuees are overlooked.

Once the immediate threat to life has passed, survival instincts prevail, printed "What to Do" instructions are located and followed, and people operate essentially on their own for an indefinite period while public agencies respond to the most urgent problems of which their communications make them aware.

After-shocks, fire flare-ups, weakening or breaking of dams and new flood crests, build-up of winds, etc, result in some relief work being undone and the posing of new threats.

Inter-agency communication is poor to nonexistent. At the end of 72 hours, the disaster area remains in virtual isolation except for helicopter service for known critical cases and official use.

Little centralized information is available. Amateur Radio operators from neighboring counties and states offer to help but are often unable to cross the roadblocks established to limit access by sightseers and potential looters. Disorganized local volunteers often lack essential skills and orientation. Costly mistakes are made and systems bog down.

The dead pose a serious health problem. Stress rises among the citizenry. Little overall assessment emerges in the first 72 hours about available emergency resources and relief supplies. Shortages are apparent and growing.

Travel continues to be difficult and slow. Relief supplies trickle in to uncertain storage locations. Some supplies are useless.

Restaurants remaining open are unable to cook without gas or to serve the masses that flood them. Food and water shortages have become critical. Normal water sources may have been cut off or contaminated.

Eventually, essential functional communication networks evolve as priorities are asserted and clusters of traffic emerge. Relief efforts are mounted when someone takes charge, makes a decision and directs the efforts of others. The command and control process of directing requires communication—the ingredient in short supply in all disasters.

At critiques following a disaster, as always, the cry is heard: "Next time we must be better prepared!"

CHAPTER EIGHTEEN

Hazardous Materials Awareness

Amateur Radio operators may encounter HazMat incidents during their travels, or they may be asked to assist with emergency communications in such incidents. Proper training is required for your own safety. Moreover, a wrong move by you during a HazMat operation can endanger not only your own safety, but also the safety of other responders as well as the entire local community.

The term "hazardous materials" (HazMat) refers to any substances or materials, which if released in an uncontrolled manner (e.g., spilled), can be harmful to people, animals, crops, water systems, or other elements of the environment. The list is long and includes explosives, gases, flammable and combustible liquids, flammable solids or substances, poisonous and infectious substances, radioactive materials, and corrosives. One of the major problems faced by emergency responders is determining which chemicals are involved and determining the potential hazards.

Hazmat crews at a pesticide spill.

Hazardous Chemicals On The Move

As the primary regulatory agency concerned with the safe transportation of such materials in interstate commerce, the US Department of Transportation (DOT) has established several systems to manage HazMat materials. These include definitions of various classes of hazardous materials, placards and other marking requirements for vehicles, containers and packages to aid in rapid identification of cargoes, and an international cargo commodity numbering system.

The DOT requires that all freight containers, trucks and rail cars transporting these materials display placards identifying the hazard class or classes of the materials they are carrying. The placards are diamond-shaped, 10 inches on a side, color-coded and show an icon or graphic symbol depicting the hazard class (flammable, caustic, acid, radioactive, etc). They are displayed on the ends and sides of transport vehicles. A four-digit identification number may also be displayed on some placards or on an adjacent rectangular orange panel. If you have spent any time on the roads, you have undoubtedly seen these placards or panels displayed on trucks and railroad tank cars. You may recognize some of the more common ones, such as 1993, which covers a multitude of chemicals including road tar, cosmetics, diesel fuel and home heating oil. You may have also seen placards with the number "1203" (gasoline) on tankers filling the underground tanks at the local gas station.

In addition to truck and rail car placards, warning labels must be displayed on most packages

A HazMat placard indicating the presence of corrosive chemicals.

containing hazardous materials. The labels are smaller versions (4 inches on a side) of the same placards used on vehicles. In some cases, more than one label must be displayed, in which case the labels must be placed next to each other. In addition to labels for each DOT hazard class, other labels with specific warning messages may be required. Individual containers also have to be accompanied by shipping papers that contain the proper product name, the four-digit ID number and other important information about the hazards of the material.

Hazardous Chemicals in Buildings

The NFPA 704M HazMat label.

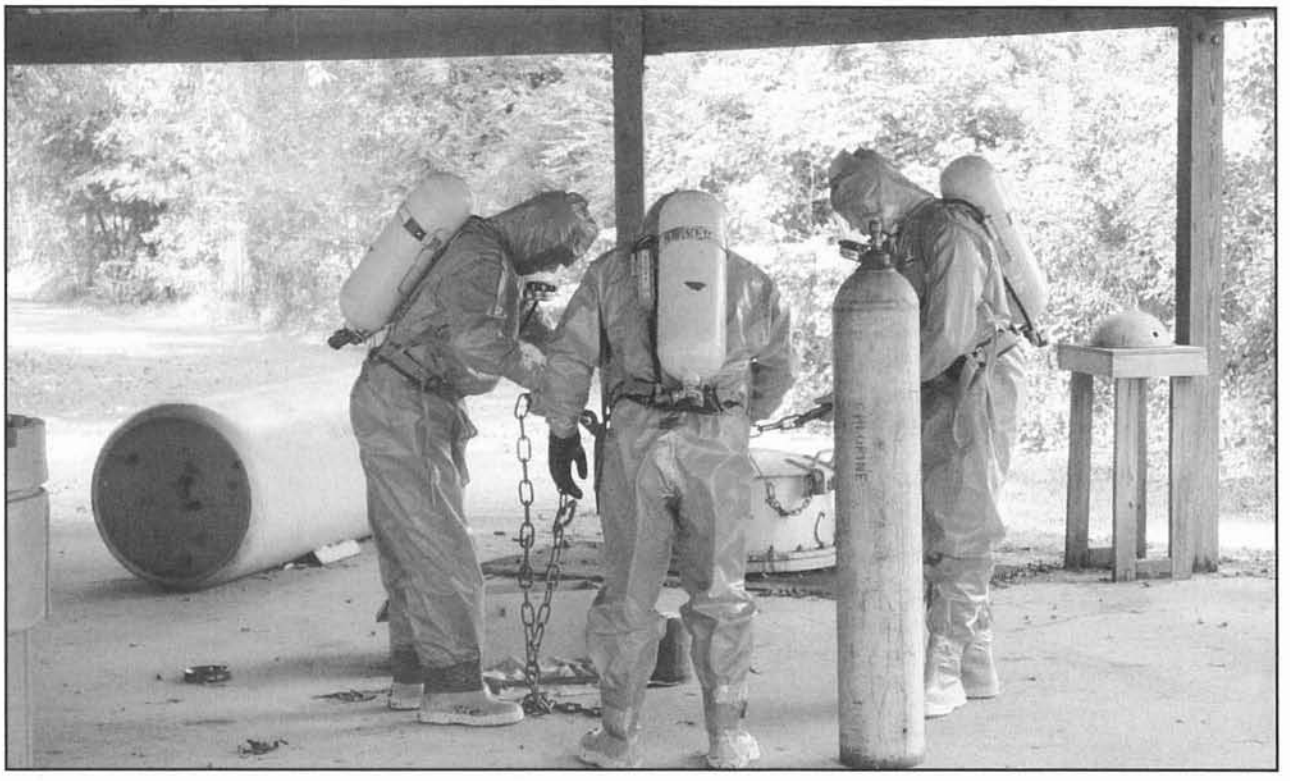
The National Fire Protection Association (NFPA) has devised a marking system to alert firefighters to the characteristics of hazardous materials stored in stationary tanks and facilities. This system, known as NFPA 704M, can also assist citizens visiting a site in identifying the hazard presented by the stored substance. Use of the system is voluntary, unless specified by local codes.

The NFPA 704M label is diamond-shaped, and is divided into four parts, or quadrants. The left quadrant, colored blue, contains a numerical rating of the substance's health hazard. Ratings are made on a scale of 0 to 4, with a rating of 4 indicating a danger level so severe that a very short exposure could cause serious injury or death. A zero, or no code at all in this quarter, means that no unusual hazard would result from the exposure. The top quadrant of the NFPA symbol contains the substance's fire hazard rating. As you might expect, this quadrant is red. Again, number codes in this quadrant range from 0 to 4, with 4 representing the most serious hazard. The NFPA label's right quadrant, colored yellow, indicates the substance's likelihood to explode or react. As with the health and fire hazard quadrants, ratings from 0 to 4 are used to indicate the degree of danger. If a 4 appears in this section, the chemical is extremely unstable, and even under normal conditions may explode or react violently. A zero in this quadrant indicates the material is considered stable even in the event of a fire. The bottom quadrant is white, and contains information about any special hazards that may apply. There are two possible codes for the bottom quarter of the NFPA symbol:

- OXY means this material is an oxidizer. It can easily release oxygen to create or worsen a fire or explosion hazard.
- The symbol W indicates a material that reacts with water to release a gas that is either flammable or hazardous to health.
- If the material is radioactive, the usual triblade "propeller" symbol for radioactivity will appear.

Guidelines for Handling HazMat Incidents

1. Once you are in a safe position up-hill and up-wind, try to identify the material. However, it cannot be over-emphasized that you *must* stay well away from the site. Do *not* be tempted to get just a little closer so that you can read placards or other items. If you cannot read these items using a spotting scope or binoculars, simply report what you can see from a safe position. If you are able to see from a safe position, look for:
   - The four-digit number on a placard or orange panel.
   - The four-digit number preceded by the initials "UN/NA" on a shipping paper, package or drum.
   - The name of the material on the shipping papers, placard, or package.
2. Call for help immediately and let the experts handle the situation. Remember, even ordinary firefighters and police are prohibited by federal law from taking certain actions at some HazMat incidents. Do not attempt to personally take any action beyond your report and preventing others from approaching. This is an instance when it is vitally important to know your limitations, not just for your own safety, but also for the safety of others.



A Hazmat team prepares to deploy.

3. When reporting a HazMat incident, include the following information:

a. Identify yourself.

b. Give your current location and the location of the incident, i.e. street address or cross streets, road and mile marker, distance from nearest town, etc.

c. Briefly describe what you see (from a distance), i.e. liquid spill, gaseous cloud, etc, and any placard numbers or other information you can safely see.

d. If a gaseous cloud or liquid spill exists, give the direction the contaminant is flowing or moving. Give any pertinent weather or other information you can observe from a safe distance that might help the experts in responding to the incident. Be concise.

CHAPTER NINETEEN

Marine Communications

The most common marine radio mode is VHF-FM, (156 to 162 MHz), with an effective range from ship to ship of 10 to 15 miles, and ship to shore of 20-30 miles. Vessels that routinely travel outside this distance generally have MW/HF-SSB, satellite communications or both. CW communication on MW/HF is no longer used.

No license is currently required for pleasure boats operating on the FM channels in US territorial waters. The FCC limits VHF-FM marine radios to a maximum of 25 watts. Radios are also required to be capable of 1-watt operation for short range and in-harbor use. For more regulatory information visit: **www.fcc.gov/wtb/marine/**.

The use of VHF and MW/HF marine radios is restricted to vessels on the water. The use of portables or mobiles to communicate with crew on shore is *not* allowed. Certain commercial users, such as marinas, marine towing services and fish canneries may be licensed for limited base operations on certain channels. In an emergency, however, the FCC rules are suspended, and you may use whatever means of communication are necessary to protect life and property.

Marine emergencies will often find you working closely with the US Coast Guard.

Channel Selection

Marine FM frequencies have been assigned channel numbers, and all are designated for specific uses. Channel 16 has been designated worldwide as a distress and calling frequency. All vessels are required to maintain a listening "watch" on FM 16 while underway. With the growth of boating and the elimination of mandatory radio licenses for certain vessels operating in domestic waters, FM 16 has suffered from abuse and overuse. To maintain the integrity of FM 16 as a distress frequency, FM 9 has been designated as an alternate calling frequency. While FM 16 can be used for routine calling, most calls should be made on FM 9. This would apply to owners of newer marine radios,

which are capable of simultaneously monitoring both FM9 and FM16 using either a scan or dual watch function.

The designated use for every marine channel is contained in the manual that comes with all VHF-FM radios. For example, FM 13 is designated for navigational purposes, and a number of channels are used for inter-ship communication. Others are not for public use. FM 83 is reserved for use by the Coast Guard Auxiliary. FM 22 is for public communication with the Coast Guard, but may not be used by boaters unless specifically instructed to do so by the Coast Guard radio operator on FM 16. FM 22 is also used by the Coast Guard to broadcast "Notice To Mariners" messages (NOTAMS), after announcing them on FM 16. FM 6 is an Inter-Ship Safety channel, and is often used for search and rescue operations. A list of all marine channels and their assigned uses can be seen at **www.fcc.gov/wtb/marine/vhfchanl.html**.

Frequencies for key marine VHF channels

FM 9	156.45	Calling
FM 16	156.8	Calling/Distress
FM 17	156.85	State/local gov't. shore sta.
FM 18	156.9	Commercial Intership
FM 21	157.05	Coast Guard
FM 22	157.1	Coast Guard—NOTAMS
FM 23	157.15	Coast Guard
FM 68	156.425	Intership
FM 69	156.475	Intership
FM 83	157.175	Coast Guard Auxiliary

Spoken Emergency Signals

To simplify identification of marine radio traffic, certain pro-words are used. When you hear one of these, you should listen carefully, write down any information and refrain from transmitting on the frequency until necessary. The pro-words are listed below with an explanation of each.

"MAYDAY MAYDAY"—The highest priority urgency call. The vessel calling is threatened by grave or immediate danger and requires immediate assistance. If you hear this call, copy the information on paper, resist the urge to contact the party calling and listen first for a reply from a Coast Guard unit. Only if no response is heard should you attempt communication with the vessel in distress.

"PAN PAN" (pronounced "pawn-pawn")—known as an "urgency" call. The vessel calling has an urgent message concerning the safety of a vessel or person. Again, copy the message, but respond only if no answer is heard. This signal may also be used by the Coast Guard for certain urgent messages to all vessels on the channel.

"SECURITE" (pronounced "securitay")—The safety signal SECURITE is used for official messages about the safety of navigation or important weather warnings. The Coast Guard can be heard using this pro-word in regular "notice to mariners" transmissions.

"SILENCE"—the Coast Guard may declare SILENCE on a specific channel. Only those units actively involved in the incident may transmit on that frequency until the Coast Guard lifts the silence order.

Incident Reporting

There are two types of incidents that hams should report directly to the Coast Guard: vessels in distress, and oil or chemical spills into public waters. The first should be reported directly to the nearest Coast Guard station. Oil and chemical spills should be reported to the Coast Guard's National Response Center at 1-800-424-8802. The secondary reporting method is via the NRC Internet Web site **www.nrc.uscg.mil**. If neither is available, try contacting the nearest Coast Guard facility.

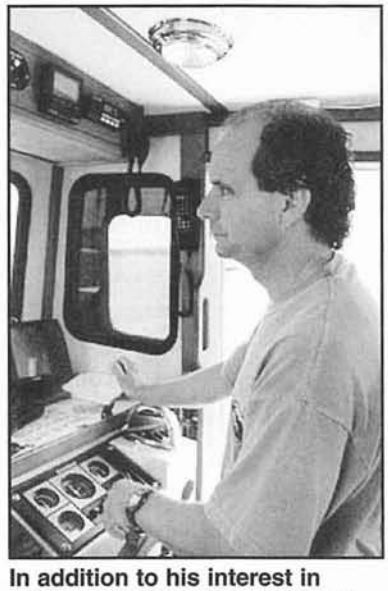
Distress Information

If you hear a distress call, listen first to see if the Coast Guard responds within a minute or two. If not, attempt to gather the following information:

- Position of the vessel involved
- Number of persons on board
- Nature of the distress
- Name of the vessel
- Call sign (if any)
- Length and type of vessel
- Color
- Any descriptive features—number of masts, flying bridge, etc
- Weather conditions on scene
- On board emergency equipment: life raft, Emergency Position Indicating Radio Beacon (EPIRB) and class of EPIRB if possible
- Frequency being used to communicate with the vessel

Once you have the information, advise all persons on board to don life jackets, and contact either 911 dispatch or the closest Coast Guard facility by phone. In some cases, a local fire or

police boat may be able to respond more quickly than the Coast Guard, who may be some distance away. Identify yourself as an Amateur Radio operator relaying an emergency message. Pass on all the information that you have gathered and assist as requested. Provide your name and phone number or other means of contact so that responding local public safety agencies or the Coast Guard may reach you if needed. It is possible that you are the only station that can communicate with the distressed vessel.



In addition to his interest in Amateur Radio, the FCC's ham radio enforcer Riley Hollingsworth, K4ZDH, is an avid recreational boater. Here, he pilots his vessel—a 26-foot Nordic Tugs tugboat replica—up Maryland's Patuxent River. His boat is equipped with SSB and FM marine radios.

Routine Communication

Calling a vessel on a marine channel is very similar to 2 meters. If using channel 9, transmit the name of the vessel you want to talk with twice, followed by your station's name twice, and the channel designation. For example: "Fishy Business, Fishy Business, this is Dream Boat, Dream Boat, Channel 9."

Listen for at least 30 seconds before repeating the call. Once you get an answer, direct the station to shift to a "working" channel: "Fishy Business this is Dream Boat; shift to channel 69." In order to avoid confusion on congested channels, FCC rules require you to identify your vessel on each transmission, although some stations shift to a shortened call after the initial contact is established. The use of 10 codes and "Q" signals is not permitted on marine VHF-FM.

MW/HF SSB Communications

Vessels that operate further offshore may operate a MW/HF-SSB unit on designated channelized international frequencies. Vessels using a MW/HF radio must also have a VHF-FM radio aboard. The U.S Coast Guard maintains "guard" on (they monitor) 2182 kHz, the calling and distress frequency, as well as other designated frequencies in this band. A complete list of MW and HF maritime frequencies and assignments can be seen at **www.navcen.uscg.gov/marcomms/high_frequency/default.htm**.

Many boaters traveling on the high seas carry HF Amateur Radio aboard. A listing of Amateur Radio Maritime Nets is contained on the ARRL Web site at **www.arrl.org/FandES/field/nets/** and in the ARRL Net Directory. These nets may also be used to pass emergency traffic.

Distress traffic received over MW/HF-SSB should be handled in the same way as on VHF-FM.

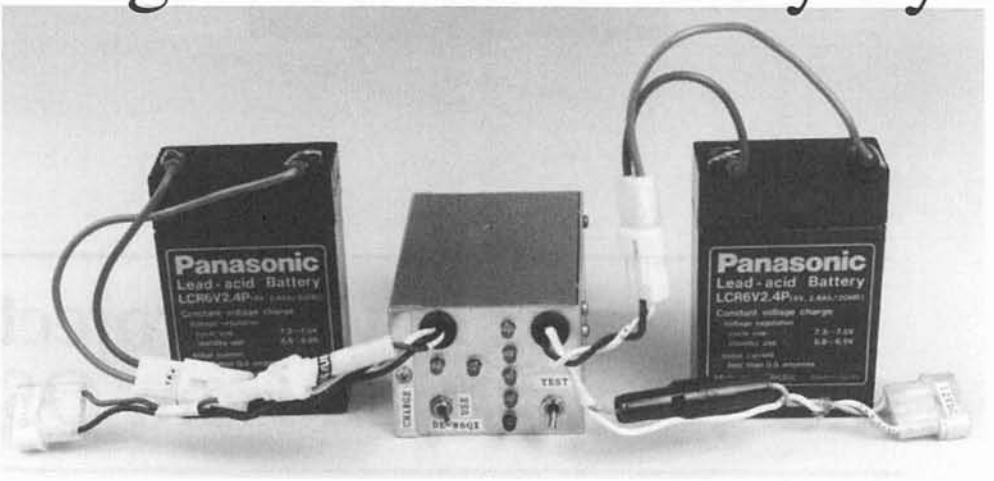
CHAPTER Twenty

Emergency Power Projects and Information from *QST*

Establishing a reliable source of power in an emergency is one of the most vexing tasks you'll face. After all, your electronic equipment is utterly useless if you can't find the energy to run it.

On the pages that follow, you'll find a collection of helpful articles selected from the pages of *QST*. The topics are diverse and include battery chargers and accessories, a solar-power charge controller, a homebrew gasoline generator (one of the most popular emergency power projects ever published in *QST*) as well as detailed advice on selecting batteries, generators and more.
—*Steve Ford, WB8IMY, Editor*

A Long-Haul H-T Battery System



It's inexpensive, portable and you can build it yourself!

By Thurman Smithey, N6QX
56 Center St
Chula Vista, CA 91910

It seems that almost every ham owns a VHF and/or UHF hand-held transceiver (H-T), undoubtedly because they serve so many purposes. Sometimes, however, an H-T's utility is limited by its standard-issue, (usually) short-duration batteries. If you're providing public-service communications for an all-day event, for example, you may find that your battery has died long before your stint is over. There

Reconditioning Small Lead-Acid Batteries

Small lead-acid batteries are available for very little money at surplus outlets, swap meets and hamfests. I have learned a few things about these batteries that I feel are worth passing along.

Most of the used batteries I have found are completely dead—showing no open circuit voltage at the terminals. A battery in this condition can still be returned to a portion of its original capacity, but it takes a bit of doing and I'm not sure it's worth the effort.

When you first place the battery on charge, it appears for all intents and purposes to be an insulator. Check it with a milliammeter, though, and you find a small current is flowing, which increases with time. If you have the facilities, put a higher voltage on it (I have used 50 volts on a 6-volt battery to get the current started). Be warned: I have also nearly melted a battery or two by not connecting a suitable resistor in the charging circuit to prevent excessive current if the battery came "alive" when I wasn't around.

The application of a higher voltage may, in some cases, not be enough to get the current flow started. I've been successful in moving the process along by applying the charging voltage in *reverse* for about 30 seconds, allowing no more than 0.5 ampere of current to flow. Strange as it may seem, this procedure is often recommended by the manufacturers of these types of batteries. The rationale is that when the battery is inactive for a long time, one of the electrodes becomes surrounded by a film of distilled water, which prevents current flow. Charging in reverse for a brief time has the effect of stirring up the juices and mixing some ions with the distilled water.

Once current flow is started, it can be increased by repeated charging and discharging until the battery begins to act very much like a normal battery. So far, however, I have not been successful in restoring more than about 60% of the original capacity of a battery that has been resurrected in this manner.

When shopping for a lead-acid battery, bring along a small load, such as a small 12- or 6-volt lamp, and use it to test the battery. If the battery lights the lamp, chances are reasonably good that you have a winner. If the battery is completely flat, you have your work cut out for you and may wind up with a mediocre at best. For example, I have one set of used 2.5 Ah batteries that did not require reconditioning. That set puts out as much or more power than the best of three different sets of 4.0 Ah batteries that *did* require reconditioning.

You'll find D-sized cells to be quite popular in the surplus market. They can usually be purchased as individual cells, or as packaged assemblies. I bought one 12-volt assembly (six cells) which I then split to make two 6-volt batteries. The assembly had a decent charge when I purchased it, and made two good 6-volt batteries.

On other occasions, I haven't been so lucky. I recently purchased 20 individual D cells (the price was right), all of which were showing 2.0 volts or greater at the terminals. When I started checking them for use in this project, I kept discarding substandard cells until only eight good ones were left. Except for the time involved, I still wound up with one good battery set for very little money.—*N6QX*

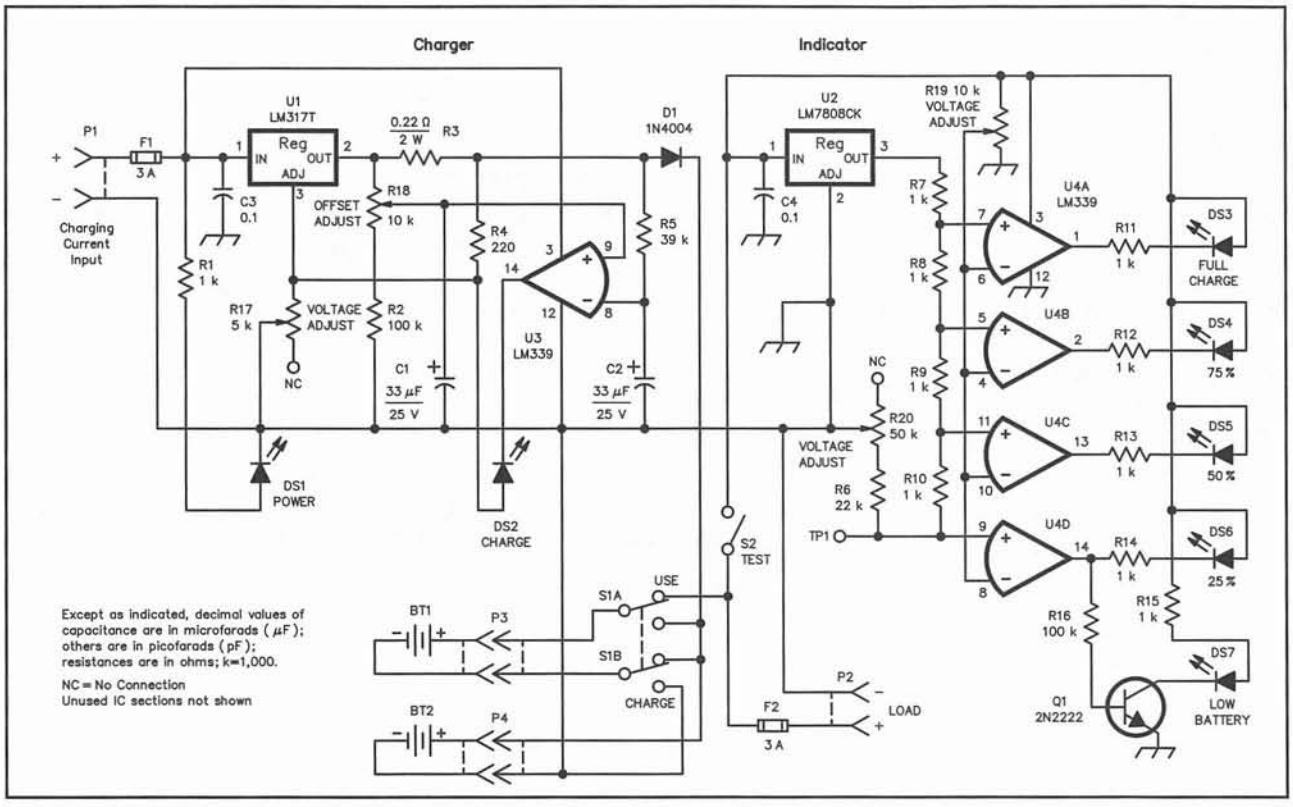


Fig 1—Schematic of the long-haul H-T battery system. Resistors are 1/4-watt, 5%-tolerance carbon-composition or film except as noted below.

BT1, BT2—Panasonic LCR6V2.4P (Digi-Key Corp, 701 Brooks Ave South, PO Box 677, Thief River Falls, MN 56701-0677, tel 800-344-4539. Digi-Key p/n P262), or Radio Shack 23-181.
C1, C2—33-µF, 25-V electrolytic.
C3, C4—0.1-µF ceramic disc.
D1—1N4004.
DS1—T-1 3/4 yellow.
DS2, DS3, DS4 DS5, DS6—T-1 3/4 green.
DS7—T-1 3/4 red.
Q1—2N2222.
R3—0.22Ω, 2 W (Ocean State RM2-0.22).
R17—5 kΩ, 1/2 W, linear taper, 15 turn (Digi-Key 3006P-502-ND).
R18, R19—10 kΩ, 1/2 W, linear taper, 15 turn (Digi-Key 3006P-103-ND).
R20—50 kΩ, 1/2 W, linear taper, 15 turn (Digi-Key 3006P-503-ND).
S1—Miniature double-pole, double-throw toggle switch.
S2—Miniature single-pole, single-throw momentary normally open switch.
U1—LM317T adjustable voltage regulator (Radio Shack 276-1778).
U2—LM7808CK voltage regulator (Ocean State 7808).
U3, U4—LM339 quad comparator (Radio Shack 276-1712).

are many other situations, including emergencies of all kinds, where a portable, heavy-duty H-T power source would prove advantageous.

Having been caught with a dead battery a time or two, I decided to develop a long-endurance battery system for H-Ts—one that could be carried comfortably in a "fanny pack," or a similar-sized bag slung from a shoulder strap. Here I'll describe the system I developed, and tell you how to build one yourself. Parts cost, including the cost of new batteries, is probably less than the list price of one H-T replacement battery. Purchasing surplus batteries can reduce the cost by approximately half.

And how well does the system work? It runs my H-T (mostly in receive mode, admittedly) *continuously* for 2 1/2 days. Charge time for the 2.5 ampere-hour (Ah) battery is only 6 to 8 hours.

System Description

My long-endurance H-T battery system requirements included:

• **Battery Charging**: The battery must be chargeable from any 10- to 15-volt dc source.

• **Automatic shut off**: The charger must shut off automatically when the battery is completely charged. An indicator must be provided to signal when charging is complete.

• **Discharge level indication**: There must be an accurate means to indicate the discharge level of the battery *as it is being used.*

• **Output regulation**: The battery output voltage must be regulated to suit the requirements of any H-T that can't be operated directly from its 12-volt output.

The Batteries

Battery choice is very important. I selected sealed, past-electrolyte,

lead-acid types. They hold their charge better than NiCds and they're readily available at reasonable prices. I chose two 6-volt batteries which are paralleled for charging, then connected in series to provide a 12-volt source for powering H-Ts. An added benefit of this switchable series/parallel approach is that it allows the use of either battery to supply 6-volt loads (video cameras, video lights, portable electric lanterns and so on).

In addition to the battery, the other three parts of the system are the charger, the battery-condition indicator and the output regulator.

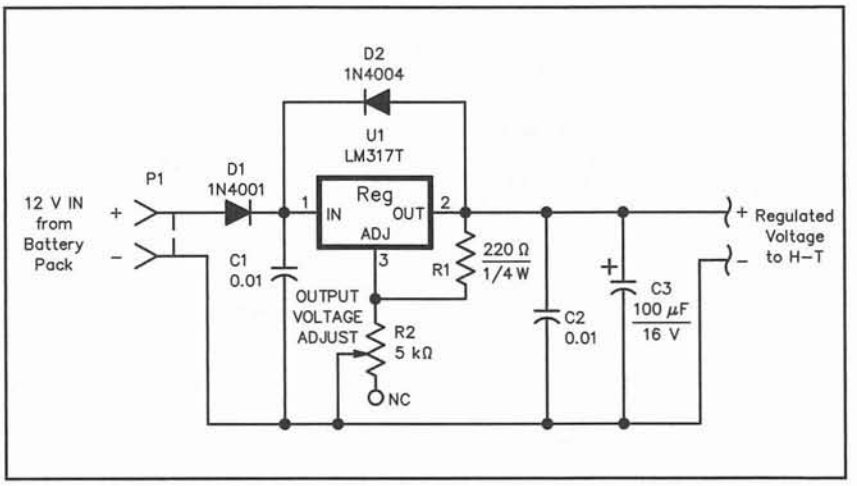


Fig 2—Voltage regulator schematic. Resistors are $^1/_4$-watt, 5%-tolerance carbon-composition or film except as noted below.
C1, C2—0.01-μF ceramic disc.
C3—100-μF, 15V electrolytic.
D1—1N4001.
D2—1N4004.
R2—5 kΩ, $^1/_2$ W, linear taper, 15 turn (Digi-Key 3006P-502-ND).
U1—LM317T adjustable voltage regulator (Radio Shack 276-1778).

Charger Circuit Description

A sealed, 12-volt lead-acid battery (2 to 4 ampere hours [Ah] capacity) is fully charged when its terminal voltage reaches about 15 volts and the charge current has dropped from its initial value to about 0.25 amperes. This assumes that the charging source maintains a constant voltage at the end of the charge cycle. The charger shut-off circuitry uses this current drop to define the full-charge condition.

The batteries are connected through connectors P3 and P4. S1 is placed in the **CHARGE** position to connect the batteries to the charger circuit. Charge current is supplied through connector P1 and applied to the input (pin 1) of the LM317T regulator, U1. A yellow LED (DS1) lights to indicate the application of charging power. R17 sets the output of U1 to 8.5 volts. R18 is adjusted so that 100 mV appears between its wiper and the junction of R3 and pin 2 of U1. With power applied to the circuit and no current flowing in R3, this offset voltage appears between pins 8 and 9 of U3, an LM339 quad comparator. In this state, the voltage at pin 9, the noninverting terminal, is 100 mV less than the voltage on pin 8, the inverting terminal. Therefore, the comparator output at pin 14 is *low*.

With batteries connected to the charger, however, the initial charging current flowing through R3 and D1 is approximately 0.8 amp, resulting in a voltage drop across R3 of about 176 mV. The inverting terminal of comparator U3 is now negative with respect to the noninverting terminal by 76 mV. As a consequence, the comparator output switches to *high*. C1 and C2 prevent a racing condition that might otherwise cause the comparator to change state before the charging current is established. At the outset, the output of U1 is less than 8.5 volts because R3 is used in the voltage-determining circuit in a negative feedback (current limiting) mode. U1's output voltage rises as the battery voltage increases, until it reaches about 8.4 volts. The charging current, and the voltage across R3, remain nearly constant at less than their initial values for most of the charge cycle. When the batteries approach their full-charge condition, their voltage rises. This decreases the charging current through R3, which results in decreased voltage across R3. The voltages appearing at pins 8 and 9 of U3 become equal when the voltage drop across R3 is reduced to the amount of the offset (100 mV). This equals a charging current of 455 mA, shared between two batteries, or about 227 mA for each battery.

When the voltage across R3 becomes *less* than 100 mV, comparator in U3 changes state and pin 14 goes low. This draws current through R4 and lights DS2. R4 is in the voltage-determining circuit of U1. The additional current drawn through R4 by U3 reduces the voltage at pin 3 of U1, dropping the output voltage lower than the battery voltage. D1 prevents current from the batteries from flowing backward in the circuit, so there is essentially no current through R3.

With no current flowing through R3, pin 9 of U3 is lower than pin 8 by 100 mV. The comparator output remains low and no additional charging takes place. The lighting of DS2 signals that the charge cycle is complete. At that point, the charging power source is disconnected, S1 is switched to the **USE** position and the batteries are available to power whatever device is connected to P2.

Battery-Condition Indicator Circuit Description

In Fig 1, U2, an LM7808CK 8-

volt regulator, provides a stable reference voltage when S2 is closed. The string of equal-value resistors (R7 through R10) functions as a four-way voltage divider. Since the resistor values are equal, the resulting voltage drops across each resistor are equal. Even so, the voltage drops can be increased or decreased (as a group) by adjusting R20. A simple computation and a voltage measurement at TP1 determines the R20 adjustment—as we'll see later.

The reference voltages are applied to the noninverting terminals of the four comparators of U4, another LM339. The inverting terminals are all connected to a common voltage which is referenced to the battery voltage. (The ratio is adjusted by R19.) Four green LEDs (DS3 through DS6) are connected to the comparators.

When S2 is closed (placing power on the indicator), the battery voltage is applied to pin 1 of U2 as well as the LEDs. If the referenced battery voltage is greater than a given comparator's reference voltage, that comparator's output is low and its LED glows. If the referenced battery voltage is less than a given comparator's reference voltage, that comparator's output goes high and its LED does not illuminate.

If the reference voltage is correct and R19 and R20 are properly adjusted, all four LEDs glow when the battery is fully charged. The first LED (DS3) switches off when 75% of the charge remains. The second LED is extinguished when a 50% charge remains. The third LED winks out at 25% and the fourth switches off when the low-voltage condition is reached (when the battery should be taken out of service and recharged). As a safeguard against the problems of negative indications, a fifth LED (DS7) was added (with Q1 and U4D acting as a switch) to provide a constant **LOW BATTERY** indication. This red LED lights when the fourth green LED is extinguished.

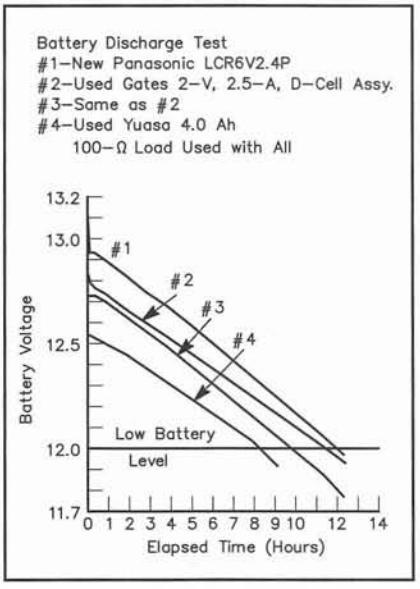


Fig 3—Battery discharge test results.

Output Regulator Circuit Description

Many H-Ts are designed to be operated on 12 volts and thus don't require this regulator circuit. For this reason, the regulator is not included on the same board with the charger/indicator. (The regulator schematic is shown in Fig 2.) If your H-T requires less than 12 volts, the regulator can be set to provide the required voltage. U1, an LM317T adjustable regulator, is at the heart of this simple circuit. R2, a 5-kΩ potentiometer, adjusts the output of U1 to suit your H-T.

You'll need to provide a connector to fit your H-T. I made an adapter for my Kenwood TR-2500 using the case of a defunct battery pack. This is a good way of making the power connection, since it is reliable and attractive. In addition, the empty case provides space for the voltage regulator.

Construction

The charger is built on a $2^1/_4$- × $3^1/_2$-inch circuit board. The prototype was constructed on perf board, but I highly recommend that you use a printed-circuit board. You can make your own or order the PC board from FAR Circuits.[1]

The circuitry is housed in a 4 × 2 × $2^3/_4$-inch aluminum box. The circuit board is supported inside the box on three angle brackets made of stiff steel wire bent to shape. The circuit board is mounted flush with the end of the box that is farthest from the indicator. This leaves space between the box and the board edge at the indicator for wires to pass to and from the switches, LEDs and grommets. The board edge on which U1 is mounted must also be flush with the side of the box so that U1 can use the box as a heat sink. The LEDs are cemented into their $^3/_{16}$-inch holes using epoxy adhesive. U1 is mounted near the board edge abutting the side of the box and is bolted to the box using an insulating kit.

Four connectors are used—one for each battery, one for the charging source, and one for the device to be powered by the batteries. Select connectors that fit your requirements.

I recommend you make a power cable with an in-line connector and fuse. Use connectors that mate with whatever dc-power source you intend to use to charge the batteries. I use a cigar-lighter plug which allows me to charge my batteries from an automobile electrical system.

The cable connecting the batteries to your H-T or other device should also include an in-line fuse. If you intend to build the voltage regulator circuit, be advised that the voltage regulator IC should be mounted on a small heat sink. This regulator can deliver up to half an amp or so on transmit.

All parts used in the project, with the exception of the new batteries, are

[1] A PC board and part overlay are available from FAR Circuits, 18N640 Field Court, Dundee, IL 60118; price $4.50 plus $1.50 shipping and handling per order. Check or money order only; credit cards not accepted. The PC-board template and part overlay are available free of charge from the ARRL Technical Department Secretary. With your request for the SMITHEY LONG-HAUL H-T BATTERY SYSTEM PC BOARD TEMPLATE PACKAGE, send a #10 SASE.

common parts which can be found in any electronics parts store or catalog. A source for the batteries is listed in the parts list (see Fig 1 caption).

Calibrating the Charger

After you've completed construction and checked your work, connect a 12-volt power source to the charger input (P3) *before* you install U3 and connect the batteries. DS1 should glow. Measure the voltage at pin 2 of U1 (referenced to ground) and adjust R17 until U1's output is 8.5 volts. Disconnect the power source and install U3. Reconnect the power source and measure the voltage difference between pins 8 and 9 of U3, adjusting R18 until pin 9 is 100 mV less than pin 8.

Calibrating the Battery-Condition Indicator

I have determined that no single calibration of the indicator unit is truly accurate with several different battery types. Fig 3 shows the discharge characteristics of four different batteries, all with the same 100-ohm load, all having just been charged using the charger. The variations are great enough to significantly affect the accuracy of the indicator.

If you buy new batteries of the type shown in the parts list, you can be confident using the discharge characteristics of battery #1 in Fig 3 to calibrate your indicator. If you have elected to use batteries that have seen previous service, I recommend that you run a simple discharge test on the batteries before performing final calibration of the indicator. (Charge the battery using the calibrated charger, then attach a 100-ohm load and plot the discharge characteristic as was done for Fig 3.)

If you have more than one set of batteries with different discharge characteristics, I recommend that you calibrate for the best set, and take into account the difference when you read the charge remaining in the weaker set(s). That way, the charge remaining at any time will be nearly equal for the different batteries.

Given a small, constant load—such as an H-T in the receive mode—the discharge voltage curve over time is nearly linear until the battery voltage drops to about 12 volts. A battery should be taken out of service and recharged when its voltage under load drops to 12 or less. This rule seems to apply regardless of the battery brand.

Fully charged battery voltage can vary considerably (see Fig 3). Depending on the brand, battery potential at the beginning of the discharge cycle can vary from 13 to 12.55 volts. Fortunately, the provisions for adjustment of the indicator are flexible enough to accommodate any batteries you're likely to find.

Calibrate the indicator based on the assumptions we've just discussed. In other words, assume that its voltage-versus-time curve will be linear with a constant, small load, and that it will need recharging when the voltage decreases to 12 volts. Compute the voltage you want to see at TP1 as follows:

$$V_{TPI} = V_{REF} \times \frac{V_{LOW}}{V_{FULL}}$$

V_{Ref} is the voltage output of U2 at pin 3, in this case 8.0 volts. V_{Low} is the voltage selected for **LOW BATTERY** indication (12 volts). V_{Full} is the battery voltage at full charge.

To calibrate the indicator, you'll need a variable-voltage power supply with a range of 11.5 to 13 volts. After determining the voltage that you want at TP1, apply 12 volts to pin 1 of U2 and adjust R20 until the voltage at TP1 reaches the desired level.

Now reduce the voltage to the V_{Low} value and adjust R19 until DS6 goes out and DS7 comes on. That's all there is to it! DS3 should now go out at a battery voltage of 12.75, DS4 at 12.50, DS5 at 12.25 and DS6 at 12.00. When DS6 turns off, DS7 lights to tell you your battery needs to be charged.

While you have your variable-voltage supply connected, check that all four green LEDs do in fact go on and off at the correct voltages. If not, you may want to try calibrating using the transition of DS5 and a calibrating potential of 12.25 volts. Then, recheck for accuracy on all four LED set points. You should be able to get them all transitioning within 50 mV of the stated voltages.

For maximum accuracy, V_{Ref} should be measured with the same voltmeter you used to set the voltage at TP1. To calibrate the indicator for another battery with different characteristics, merely substitute the appropriate numbers in the equation above. To further improve accuracy, I measured all the 1-kΩ resistors used in the project and selected the four that were most nearly equal for R7 through R10.

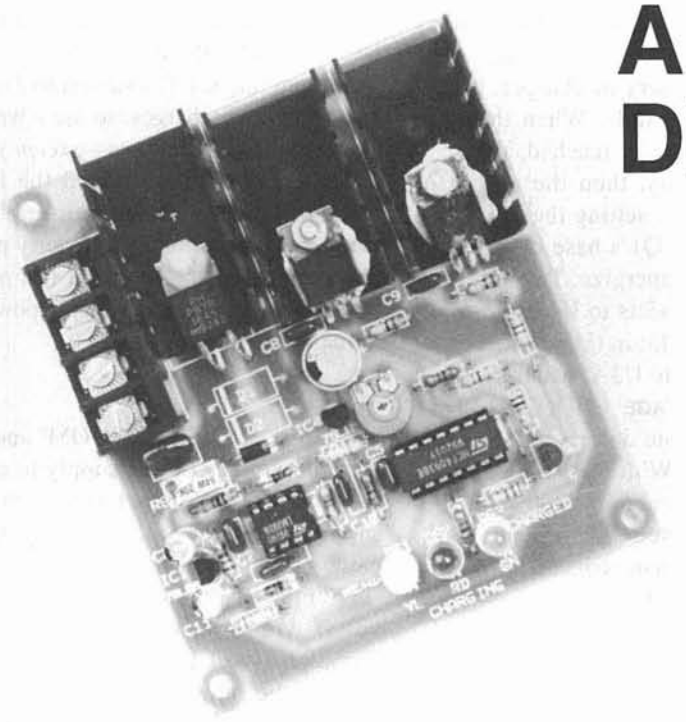
Additional Thoughts

I use a common fanny pack to house the batteries and the charger/indicator when I want to carry the system around. In the one I bought, there's plenty of room for the equipment and accessory cables. Although I elected to discontinue using large batteries, I was able to get a pair of 4.0-Ah batteries in the pack and the weight wasn't too objectionable. The box housing the charger/indicator gets quite warm while batteries are being charged, so it should not be left in the pack when charging is in progress.

Summary

I've had a great deal of enjoyment in developing this low-tech project, and even more enjoyment out of using the long-haul battery system with my own H-T. Try one yourself and I'm sure you'll like it as much as I do.

Thurman Smithey, N6QX, was introduced to Amateur Radio in the late 1930s as a high school student. It wasn't until his retirement from the Navy, 30 years later, that he finally obtained his license. He was first licensed to the General class as WA6FUY in 1968. Thurman acquired a sailboat the same year and has enjoyed operating maritime mobile while doing some blue water sailing. Thurman holds a Master of Science degree in Engineering Electronics.



A Low-Voltage Disconnect

Whether you're operating a repeater, operating on emergency power or just watching TV in your RV, this little gadget protects your batteries from damage.

By Michael Bryce, WB8VGE
2225 Mayflower NW
Massillon, Ohio 44647

Many Amateur Radio stations use batteries to power their radio equipment during commercial electric power outages. Some of us use battery power all the time in the shack. Keeping an eye on the battery's charge sometimes can't be done (or is forgotten altogether) until you are unexpectedly—and unwillingly—off the air!

What you need is a battery watchdog—something to keep track of the battery and disconnect loads when the battery just about goes kaput. No matter what your use of battery power—whether you own a camper, RV, or just fish on the lake beside your cottage—this contraption does the battery monitoring for you and protects your battery from severe discharge as well. Repeater owners and operators may find the device an ideal way to extend operating time while on emergency power.

What's It Do?

The low-voltage disconnect (LVD) automatically disconnects a load from the battery before damage is done to the battery or the load. The potential across a discharging battery's terminals depends on the battery's state of charge and the load's discharge rate. This circuit monitors the battery terminal voltage, and when it reaches a preset level, a relay is de-energized disconnecting the load from the battery. There's an approximate 5-second delay before the device senses the low-voltage set point and the relay drops.

Take a look at some of the features of this watchdog:

- User-adjustable turn-off voltage.
- User-adjustable reset voltage.
- Built-in delay to ignore temporary low-voltage conditions.
- 30-A-capacity relay contacts.
- Low current consumption.
- Easy construction using a readily available PC board and components.

The load can be connected directly to the LVD's relay, or its relay can drive an off-board, heavy-duty power relay, if need be. You can also use the PC-board-mounted relay to control a 120-V ac load (I'll talk about that later). The LVD can also supply logic to a repeater controller, too.

Circuit Description

To see how the circuit works, refer to Fig 1. U5, an LM317LZ 100-mA adjustable-voltage regulator, creates a reference voltage for the comparators. This voltage (4.00) is set by R30 (**REFERENCE ADJ**), a 1-kΩ potentiometer. R27 places a 4-mA load on the regulator's output and improves regulator stability. U2C buffers the reference voltage. From here, the reference voltage goes to the voltage comparators. D1, a 1N4001 diode, protects U5 from reversed power-supply voltage polarity.

R1 and R2 halve the battery terminal voltage. R3 and C9 help filter out battery-line noise. U2B acts as a buffer between the voltage divider and the battery sense line.

Two set points are needed to control the LVD. One turns on the LVD. That causes K1 to drop out, discon-

necting the load. The other set point turns off the LVD, closing the relay contacts and reconnecting the load. If it weren't for the two different set points, the LVD would constantly switch on and off. The difference in the set-point voltages allows the battery to recover before the load is reconnected. (This assumes you have some means of recharging the battery after the load has been disconnected.)

The voltage comparators are nearly identical. The battery voltage, now divided by two, is applied to two voltage dividers. Let's first look at the trip comparator.

The battery's output voltage is divided in half and applied to comparators U1C and U1B through U2B. If the battery was discharged to 10 volts,[1] the trip comparator (U1C) input would see less than 5 volts. The reference voltage at pin 10 is 4 volts. By adjusting R5 (**LVD TRIP**), we can set the comparator to switch states when the input voltage at U1C pin 9 equals the reference voltage. D5 and R12 provide a bit of hysteresis to keep U1C from oscillating. Because U1C may not provide the needed high-to-low positive switching action, a second op-amp section (U1D) is used. U1D provides the switch-like on/off state needed by the delay circuit composed of D4, R16 and C8, which provides a delay of about 5 seconds. Again, to provide the required logic levels, U2A is used. Its output goes to the SET point of the R/S latch, U4A and B.

The **ON RESET** circuit (U1B) works similarly, but has no delay circuit. U1B's output is routed through U1A and goes to the RESET of the R/S latch, U4A.

When the battery voltage is above the LVD trip point, the output of the R/S latch (U4A pin 3) is high. This turns on Q1, a TIP-120 NPN Darlington power transistor, which energizes K1. A 1-W, 47-Ω resistor (R18) limits relay current. This minimizes the overall current demand of the LVD. D8 protects Q1 from the back EMF produced when the relay coil's magnetic field collapses.

As the battery discharges, its terminal voltage falls. When the LVD turn-on voltage is reached, there's a 5-second delay, then the output of U2A goes low, setting the R/S latch. This removes Q1's base drive, causing K1 to de-energize. The output of U4 pin 4 connects to U4 pin 8 to allow the oscillator (U2D) to output through U4C to U3A, which turns on the **LOW-VOLTAGE** LED, DS1. DS1 flashes at a rate determined by R25, R26 and C7. With the values shown, the on-time is about 1/20th of a second. Otherwise, DS1 remains dark. This arrangement reduces the circuit current drain during a low-voltage battery condition.

Construction

There's nothing critical here: perfboard, wire-wrap, dead-bug or PC-board construction are all suitable. A PC board is available[2] as well as a complete kit of parts.[3] Using a PC board speeds construction and makes troubleshooting easier.

You can buy most of the parts from a well-stocked Radio Shack store. Mouser Electronics[4] can supply the parts "the Shack" does not carry. In both cases, the single exception is the relay. Obviously, the one specified fits the PC board. Secondly, it has a hefty contact rating (30 A) and is inexpensive (less than $4). This relay is available from Digi-Key.[5] Certainly, you can use a different relay, but you'll probably have to mount it off-board. Also, you may have to change R18's value, as it's dependent on the relay's coil current. The value shown is calculated for the relay identified in the caption. (By the way, mount R18 with a 1/4- to 1/2-inch clearance between the resistor body and the PC board. This allows air to circulate around the resistor and prevents the dissipated heat from discoloring the PC board.)

Component values aren't critical. Use equivalent parts you have on hand. If you don't have a 300-kΩ resistor, a 270-kΩ will work just fine. (The ±10% rule of thumb can be safely applied.) Use sockets for the ICs and be careful when handling U4: It's subject to damage by static discharges, so use a wrist strap. Install all the parts—*except for C8*. After you've assembled the PC board, check your work to ensure the diodes and capacitors are properly polarized. Ensure you have the ICs oriented properly before you apply power to the board.

Set Up and Test

You'll need a digital VOM[6] and a variable-voltage power supply to adjust the LVD. Connect your power supply to the terminal block at the battery terminals.

Set the power supply output to 14 volts. Apply power to the board. Probe pin 10 of U2. Verify the presence of the reference voltage; in all probability, it's not 4.00 volts—yet. Move the probe to U2 pin 8 and verify the reference voltage is there, too. Now, adjust R30 (**REFERENCE ADJ**) until the voltage at U2 pin 8 is 4.00 volts. Next, set your power supply to 10.5 volts. Measure the voltage at pin 7 of U2. It should be 5.25 volts (half of 10.5 volts).

Adjustment Method

First, *remove C8* (in case you forgot the earlier warning and soldered it in) from the PC board. This defeats the delay circuit. Turn both R7 and R5 fully counterclockwise. Set your power supply output to 13.5 volts. Connect the power supply to the LVD, then turn it on. The **LOW VOLTAGE DISCONNECT** LED (DS1) should be blinking. Slowly adjust R7 (**ON RESET**) until the relay closes and DS1 goes dark. Reduce the power supply output to 10.5 volts. Slowly turn R5 (**LVD TRIP**) until K1 drops out and DS1 begins to flash. Verify the two set points by raising the power supply output voltage to 13.5 volts. K1 should energize. Reduce the voltage to 10.5 volts and K1 drops out. *Now* you can install C8! You're done!

Troubleshooting

If you can't get the circuit to

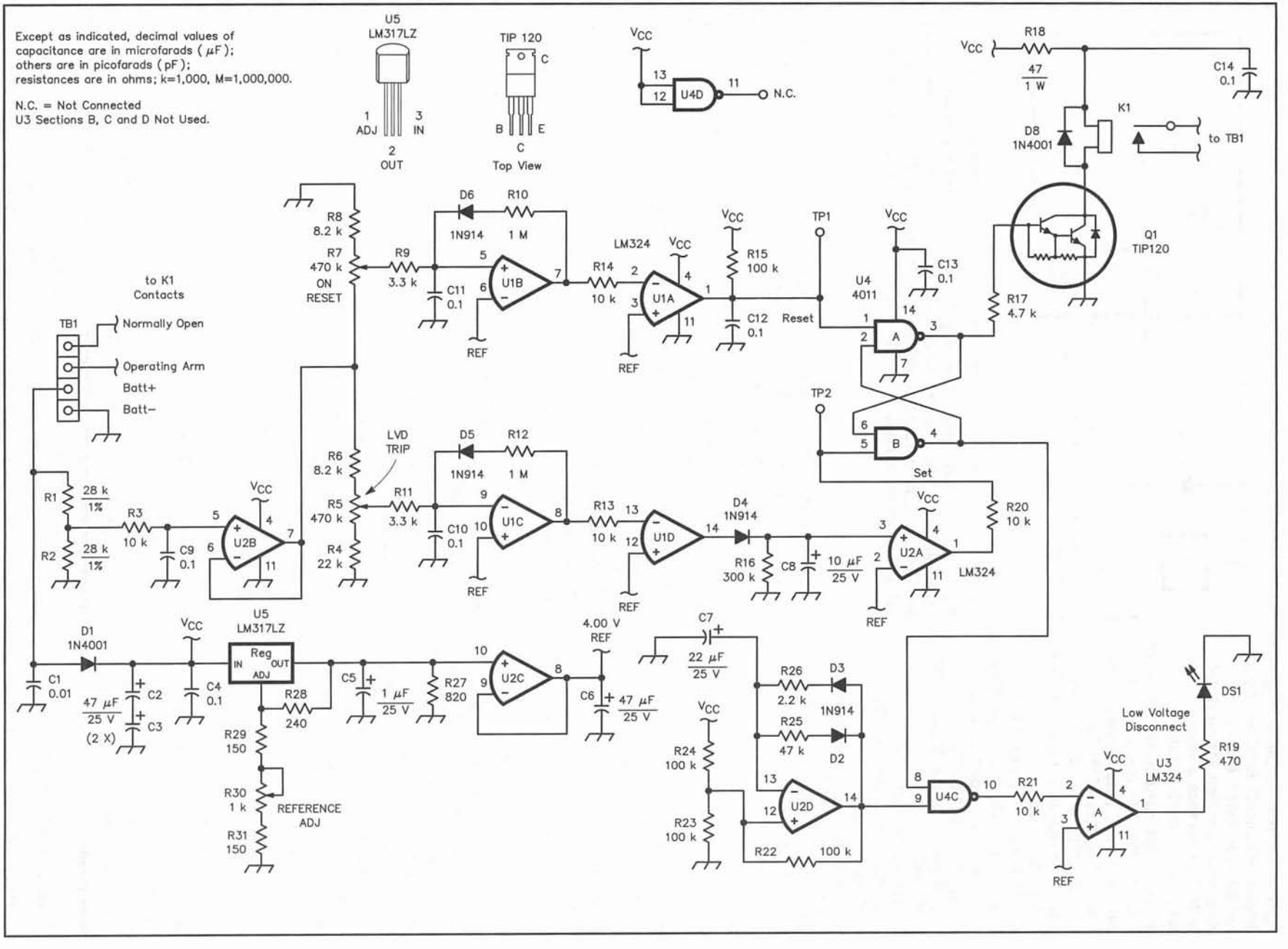

Except as indicated, decimal values of capacitance are in microfarads (μF); others are in picofarads (pF); resistances are in ohms; k=1,000, M=1,000,000.
N.C. = Not Connected
U3 Sections B, C and D Not Used.
U5 LM317LZ
1 ADJ
2 OUT
3 IN
TIP 120
B
C
E
Top View
Vcc
U4D
N.C.
R18
47
1 W
C14
0.1
K1
D8
1N4001
to TB1
Q1
TIP120
to K1 Contacts
TB1
Normally Open
Operating Arm
Batt+
Batt−
R8
8.2 k
R7
470 k
ON RESET
R9
3.3 k
D6
1N914
R10
1 M
C11
0.1
U1B
REF
LM324
R14
10 k
U1A
R15
100 k
C12
0.1
TP1
Reset
U4
4011
C13
0.1
R17
4.7 k
TP2
Set
R20
10 k
LVD TRIP
R6
8.2 k
R5
470 k
R4
22 k
D5
1N914
R12
1 M
R11
3.3 k
C10
0.1
U1C
R13
10 k
U1D
D4
1N914
R16
300 k
C8
10 μF
25 V
U2A
LM324
R1
28 k
1%
R2
28 k
1%
R3
10 k
C9
0.1
U2B
D1
1N4001
C1
0.01
47 μF
25 V
(2 X)
C2
C3
C4
0.1
U5
LM317LZ
Reg
IN
OUT
ADJ
R28
240
R29
150
R30
1 k
REFERENCE ADJ
R31
150
C5
1 μF
25 V
R27
820
U2C
4.00 V REF
C6
47 μF
25 V
C7
22 μF
25 V
R26
2.2 k
D3
1N914
R25
47 k
D2
R24
100 k
R23
100 k
U2D
R22
100 k
U4C
R21
10 k
U3
LM324
Low Voltage Disconnect
DS1
R19
470

Fig 1—Schematic of the low-voltage disconnect circuit. Equivalent parts can be substituted. Unless otherwise specified, resistors are 1/4-W, 5%-tolerance carbon-composition or film units.

U1-3—LM324 quad op amp (Mouser 511-LM324; Digi-Key LM324N).
U4—4011 quad gate (Mouser 511-4011; Digi-Key 4011CD).
U5—LM317LZ 5-V, 1-A adjustable regulator (Mouser LM317LZ; Digi-Key LM317LZ).
K1—Potter and Brumfield T-90 series; 12-V dc, 155-Ω coil, SPST, 30-A normally open contacts (Digi-Key PB110-ND).
TB1—Terminal block (Mouser 506-8PCV-04).
R5, R7—470-kΩ trimmer potentiometer (Mouser 531-PT15D-470K).
R30—1-kΩ trimmer potentiometer (Mouser 531-PT15D-1K).
Q1—TIP-120 Darlington power transistor (Mouser 511-TIP-120; Digi-Key TIP120PH-ND).

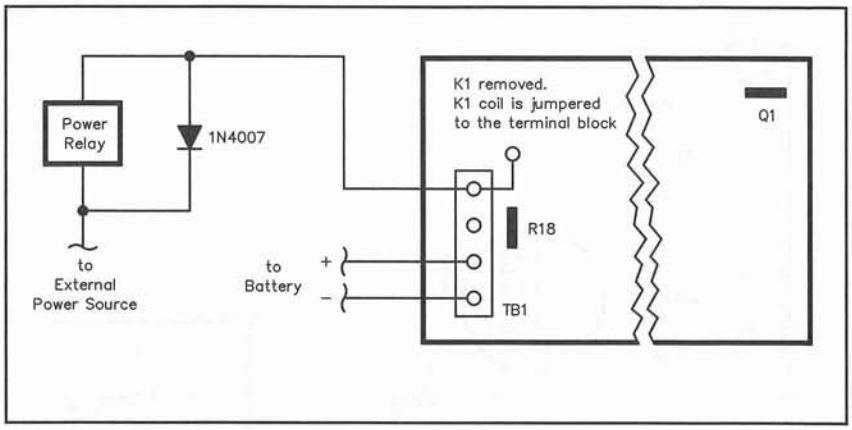


Fig 2—An off-board solid-state relay provides an excellent means of controlling 120-V-ac operated loads. Here, the relay derives its operating current and voltage from the battery being monitored. The resistance value and power rating of RX is chosen for proper relay operating current.

work, first check for the presence of the reference voltage. Without it, you'll be dead in the water from the start. Check for 4.00 volts on pins 3, 6, 10 and 12 of U1, and at U2 pin 2 and U3 pin 3.

If the comparators won't switch (and you have the proper reference voltage) check the battery sense line by checking the output voltage at U2 pin 7. (This voltage should be one-half of the power-supply voltage applied to the battery sense line.) As you can see, replacing U1 replaces *all* the battery sense comparators.

When the battery voltage is at 10.5, you'll be able to see the delay action by probing U2 pin 3. At this pin, you'll see the voltage slowly drop during the 5-second delay period.

If you used a relay other than the one specified, the value of the current-limiting resistor (R18) may be too high to allow the relay to energize. Try reducing R18's value (or short it out).

Hooking Up the LVD

With only four wires, hook-up is a breeze! Simply connect the battery you intend to monitor to TB1's battery terminals. K1's contacts are completely isolated from the battery. By connecting a jumper from the +12-volt battery terminal to one of the relay contacts, you can deliver battery power through the relay contacts to your load.

Remember, although K1's contacts can carry 30 amperes, voltage drop caused by long wire runs can have an effect on the load. If you need to control heavy current loads, use K1 to control a power relay located right at the load. Install a protective diode across the power-relay's coil terminals to prevent inductive kick-back.

You can use K1's contacts to control logic levels to a repeater. Connect K1's contacts to ground or +12 V via a current-limiting resistor. If you have a repeater controller and it requires a logic input, this is one way to go.

Controlling a 120-V AC Load

Although K1's contacts easily handle a 120-volt load, having an exposed 120-volt line connected to TB1 would keep me up at night! A safer way to control such a load is to use an off-board solid-state relay (see Fig 2).[7] (A solid-state relay is an optically coupled device that provides excellent isolation between the load and the driving source. In this case, between the 120-V ac mains and your battery.) Solid-state relays with various control voltages are readily available. RX, an external resistor, serves to limit the current flowing to the solid-state relay. By properly altering the value of RX, you can use a 5- or 12-volt control line. As mentioned earlier, the battery can supply power to operate the solid-state relay via K1's relay contacts.

Life with an LVD

While the LVD certainly protects your battery from deep discharge, it's not perfect. (What is?) Every LVD consumes *some* power from the battery it's trying to protect. In this case, when the LVD has the relay pulled in, it draws about 90 mA. If you run the LVD 24 hours a day, you have a 2.16-Ah load just for the LVD. Even with the relay off, and the battery at 10.5 volts, the LVD draws about 12 mA. So, if your battery is being charged by a solar array, be sure to include the LVD load requirements when performing your sizing calculations. To save power when you're not using the load, turning off the LVD automatically turns off the load connected to the relay.

If your battery is charged from a

120-V ac charger, you'll not have to worry about the extra LVD load. Repeaters operators normally have a battery back-up system constantly being charged. When the grid power fails, the battery takes over. When the battery discharges to the point that the LVD trips, the LVD can then take the power amplifier off line to extend battery operation until the grid power comes back on.

The LVD load should not be your main load. *Shedding* loads is the main job of the LVD. You don't want to have it shut down *everything,* but disconnect what you can live without. For instance, in an RV, you may want to connect the running lights to the LVD and leave your TV bypassed. When the battery becomes so low as to trip the LVD, the running lights will be disconnected. (Given the nature of what's on TV these days, it's probably a better idea to take the TV off line and keep the running lights on!)

Here's another example of choice: You have a sailboat docked in the lake. A bilge pump is connected to the LVD. If too much water leaks into the boat and the pump is running all the time, the LVD will disconnect the pump from the battery protecting the battery from damage. With the pump disconnected from the battery, the pump won't work any more and before you know it, your sailboat has become a submarine!

A much better way to prevent your sail- boat from sinking is to have the LVD warn you of the discharged battery. The warning could be as simple as a flashing light or a buzzer. If you really want to go to the extreme, you could combine the LVD and the METCON II[8] for telemetry. The LVD keeps a constant eye on your batteries, while you work the world on your radio, or just fish in the lake by your cottage.

Notes

[1]A lead-acid battery is generally considered dead when the terminal voltage is 10.5 under load.

[2]A PC board for this project is available from FAR Circuits, 18N640 Field Ct, Dundee, IL 60118-9269. Price: $12, plus $1.50 shipping. A PC-board template package is available free from the ARRL. Address your request for the LOW VOLTAGE DISCONNECT TEMPLATE to: Technical Department Secretary, ARRL, 225 Main St, Newington, CT 06111. Please enclose a business-size SASE.

[3]A complete kit of parts, including the PC board and relay, is available from SunLight Energy Systems, 2225 Mayflower NW, Massillon, OH 44647. Price: $55 plus $3 shipping.

[4]Mouser Electronics, 2401 Hwy 287 N, Mansfield, TX 76062; tel 800-346-6873, 817-483-4422, fax: 817-483-0931.

[5]Digi-Key Corp, 701 Brooks Ave S, PO Box 677, Thief River Falls, MN 56701-0677, tel 800-344-4539, 218-681-6674, fax 218-681-3880.

[6]You can use an analog meter to calibrate the LVD, but a digital voltmeter provides better resolution.

[7]Available from All Electronics Corp, PO Box 567, Van Nuys, CA 91408-0567, tel 800-826-5432, 818-997-1806, fax 818-781-2653.

[8]P. Newland, "Introducing METCON, a New Remote control and Telemetry System," QST, Jan 1993, pp 41-47.

By Ken Stuart, W3VVN

Honey, They've Shrunk the Batteries!

Microminiaturization of electronic components has taken a giant leap forward in the past few decades. Combining these components into integrated circuits has also resulted in squeezing more and more circuitry into smaller and smaller space to the extent that couldn't have been imagined some 40 or 50 years ago. For example, one prophet of the electronics industry went on record around 1950 as saying that he foresaw computers in the year 2000 as weighing less than one-and-a half tons! Well, he was right, and then some. Today's laptop has a capability that vastly exceeds the computer of his day, which took up rooms of space and gobbled up electricity at a rate that would supply several of today's homes.

With the ensuing emergence of electronic miniaturization has come a formidable market of personal electronics products such as the cellular and portable phone; laptop computers and pocket organizers; H-Ts; compact disk, cassette and MP3 players; pocketable GPS navigation units; and many others. The development of these mini electronic gadgets has brought about the need for smaller and smaller batteries with greater stored energy.

Driven by the development of these consumer products with their smaller power sources, battery technology has taken giant leaps forward in the past decade. Consumer items like the laptop computer, cellular phone and similar portable products have forced technology to produce lighter, smaller cells with increased energy storage. As a result, new battery chemistries—for example, nickel metal hydride (NiMH) and lithium—are rapidly replacing older technologies such as nickel cadmium. As in any technology, however, one doesn't get something for nothing, and there are few miracles. It pays to know the tradeoffs before making a switch in battery types. This article is an overview of some of the new varieties of battery cell now available, and will provide comparisons between new and old technologies.

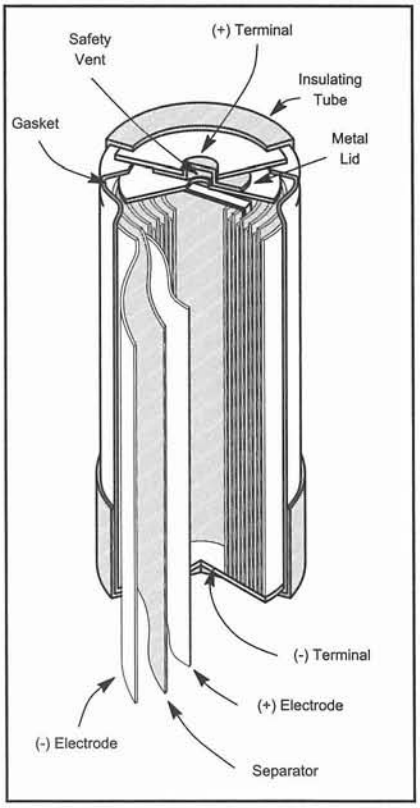


Figure 1—Cutaway drawing of a NiMH cell. Except for the cathode, which is made of hydrogen-storage metal instead of cadmium, the construction is similar to that of the NiCd cell.

Nickel Cadmium (NiCd): The Old Standby

For many years the reigning king of the miniature rechargeable battery, the NiCd cell still has a number of things to recommend it. Although largely superseded by the nickel metal hydride, the NiCd cell still leads the field in the number of charge/discharge cycles, easily reaching to a thousand or more for larger volume cells like the "C" and "D" sizes. It is also the undisputed champ in providing extremely high output currents for its cell size, which is why it is still the predominant battery in Amateur Radio hand-held transceivers (HTs).

Recently, the environmental impact of landfill disposal of NiCds has become an issue. Cadmium metal is used to form the anode of the cell (the *negative* terminal of a cell, since the anode of a device is defined as the terminal into which current flows). Cadmium is one of the most toxic of metals, and disposal of these cells has become a serious problem. In fact, there are recycling programs

in several areas of the country for used NiCds, and we should take advantage of them. The Rechargeable Battery Recycling Corp (1000 Parkwood Cir, Ste 450, Atlanta, GA 30339, tel 678-419-9990, **www.rbrc.org**) is a nonprofit organization that provides recycling assistance in the US. With the improvement in the capability of NiMH cells, the thrust now is to change to nickel metal hydride, which eliminates the cadmium problem.

Memory

NiCds have gotten a lot of bad press because of the "memory" effect, which is now often referred to as "voltage depression." It's not nearly as prevalent a problem as it sounds, and if it does occur, it is completely reversible. We now know that this effect is caused by crystallization of the nickel electrode which reduces the area of the active material available for chemical action. Nickel metal hydride (NiMH) cells also have nickel anodes, however. Therefore, contrary to popular belief, the NiMH cell is also subject to anode crystallization and therefore memory. The memory effect is not seen in NiMH cells as often as in NiCd, simply because the NiMH cell does not have the longevity of NiCd.

The memory effect can be avoided and reversed by subjecting the battery to a hefty discharge and full recharge once every couple of months. Note that this does *not* mean discharging the battery to zero, since full discharge can cause cell reversal which can shorten cell life.

Nickel Metal Hydride (NiMH): Serious Contender

The nickel metal hydride (NiMH) cell has been evolving for a number of years, and until recently it was not a serious contender for the throne occupied by the NiCd. Figure 1 is a cutaway view of an NiMH cell. Recently, the state-of-the-art of the NiMH cell has advanced to where it can often be considered as a one-for-one replacement, although it has only about one-third the number of charge-discharge cycles (cyclic lifetime) and higher internal resistance than nickel cadmium. Figure 2 shows a NiCd (left) and NiMH battery pack for a popular H-T, while Figure 3 shows three AA cells—from the left, an older NiCd, a higher-rated NiCd and an NiMH.

Advantages

NiMH batteries have approximately the same electrical characteristics as NiCd with one exception—they have about 30 to 50 percent more energy capacity per cell.

- Per-cell cost is now competitive with NiCd.
- Readily available in single cells or in ready-to-go battery packs for popular ham transceivers.
- Can be recharged using the same charger as the NiCd battery that it replaced; no new charger is needed.

Disadvantages

- NiMH cells have fewer charge-discharge cycles than NiCd. Typical cyclic lifetimes are around 500 charge/discharge cycles as compared to about 1500 for NiCd. For most hams, this is not a significant problem.
- Internal resistance is about twice that of NiCd, which means that NiMH will not provide as much output power in higher power H-Ts as NiCds.
- NiMH self-discharge is greater than NiCd—about 30% per month, compared with NiCd's 20%.

As the NiMH technology continues to improve and prices drop, the NiMH cell will, in all likelihood, supplant nickel cadmium.

Lithium-ion (Li-ion): Up and Coming

In the past decade, Lithium battery technology has made Li-ion batteries an up-and-coming contender in the portable battery field. Already, rechargeable lithium cells are making their way into cellular phones, where their superior energy storage capability provides increased talk and standby time.

Lithium primary (non-rechargeable) cells were the first of the family to evolve. Starting about a dozen years ago, the lithium button cell first appeared in electronic watches where it gave years of operating life before its power was consumed. Its main advantages are that it has an energy storage capability of about twice that of alkaline cells by volume, and about four times by weight, as well as an extremely long storage life. Lithium primary cells are now available in the popular "flashlight" sizes, but they are expensive and not readily obtainable. These cells are commonly seen in such applications as key-chain flashlights, wristwatches and memory backups in computers and ham rigs.

Lithium secondary, or rechargeable, cells are becoming popular for cell phone and laptop battery packages. Their light weight and high energy storage capacity provides longer life while not burdening the consumer with a heavy power pack. Although many lithium rechargeable technologies have been developed, the most popular is the lithium-ion (Li-ion). See Figure 4.

Rechargeable lithium cells, however, have had some problems. In its pure state, lithium metal is extremely reactive, and any contact with water results in the liberation of hydrogen and possible fire or explosion. In lithium cells, the lithium is normally in the form of a salt, which makes it non-reactive. Certain battery manufacturers, however, have stated that with overcharging, lithium metal can be extracted from the salt inside the cell casing, and that reactions have taken place causing rupturing of cell cases, and damage to the equipment in which they were installed. Therefore, charging of lithium batteries is usually handled by special protective balancing and charging circuits built into the battery package. These circuits carefully regulate the state of

charge, and terminate charging before overcharge can occur.

Early lithium batteries had a relatively high internal impedance that was about three times higher than that of NiCds. Recently, this internal impedance has been lowered as a result of improved manufacturing techniques and research. Although the impedance is still not as low as NiCds, it is sufficiently low for application in some Amateur Radio H-Ts. Yaesu's VX-5R is a 5-W unit with a small Li-ion battery as standard equipment (see Figure 5).

One negative point is that Li-ion batteries do not have a particularly long lifetime even if they are not used. One manufacturer has stated that the lithium rechargeable cell can last only about two to three years after manufacture. On the good side, their rate of self-discharge is very low—only about 10 percent per month—which means they are excellent for standby equipment applications.

Sealed Lead-Acid (SLA): Old Standby

Although the rechargeable sealed lead-acid (SLA) cell is heavy and bulky, and doesn't hold a lot of energy for its size and weight, it has the advantage of a very low self-discharge rate. In addition it is relatively inexpensive and very reliable. Complete batteries are readily available at electronics dealers. One can come across batteries that have been routinely pulled from emergency lighting systems that still have lots of life left in them. One manufacturer, Quantum, used to provide a battery pack specifically made for ham radio use; although they have discontinued this model, they have a higher power alternate with state-of-charge indication and included charger.

Larger SLA battery packages, which can power a desktop or automotive transceiver for hours on end, can also be found at automotive accessory dealers, discount buyer's "clubs," and so forth. These are sold as emergency automobile starting units, complete with jumper cables and cigarette lighter outlets. The au-

Figure 2—Two 13.8-V battery packs for my ICOM IC-2GAT H-T. The pack on the left is an older NiCd unit having a rating of 1200 mAh. The one on the right is an NiMH with a rating of 2700 mAh. They have identical case sizes.

Figure 3—Three different types of AA-size cells. At left, an older NiCd cell rated at about 600 mAh; in the middle, a newer NiCd cell with an 1100 mAh rating; at the right, an NiMH cell rated at 1600 mAh. Note that 1300 mAh is a "comfortable" rating for an NiMH cell of this size; higher capacity cells are readily available.

Figure 4—Removable Li-ion battery back for ICOM H-Ts.

Figure 5—Small Li-ion battery pack for the Yaesu VX-5R H-T.

thor has used one of these units over the past few years to power a Kenwood TM-V7A for an entire day of communications at Scouting events. Figure 6 shows different sizes of gel-cell lead acid batteries.

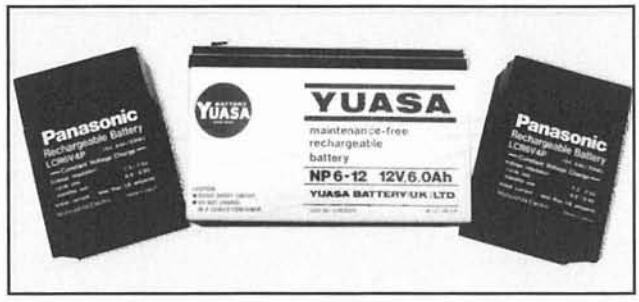


Figure 6—These gel-cell lead-acid batteries are rechargeable and won't leak.

Reusable Alkaline

Before nickel cadmium cells were readily available, it was fashionable to "recharge" flashlight batteries by passing a very small current into them for a day or two. Devices to perform this recharging function were sold at novelty and specialty stores, and under certain circumstances a certain amount of energy could be restored to a discharged cell. Unfortunately, the amount of energy that could be recovered was nowhere near what a new cell from the dealer's shelf could deliver, and continued recharging could result in leakage of electrolyte into a flashlight or radio.

With the thrust to provide a cheaper cell than NiCd and the desire to give the consumer a cell that would provide the higher terminal voltage of the alkaline cell, the idea arose to return to the old flashlight battery recharger, and the reusable alkaline was born.

Reusable alkalines do not have a high cyclic life. Testing performed on these cells showed that after one initial discharge and recharge, the energy capability was down to only about 60 percent of the original capacity. Cyclic life is also highly dependent upon the depth of discharge. Only about 10 charge/discharge cycles can be expected if the cell is repeatedly discharged to depletion, more if the cell is only slightly discharged and then recharged.

A rechargeable alkaline's internal resistance is also higher than an equivalent regular alkaline cell, which limits the reusable cell's capability for high discharge current applications. This all but eliminates the reusable alkaline for most ham radio applications.

Self discharge, however, is excellent for these cells and is only about 0.3 percent per month. This makes them a good choice for emergency flashlights that are used for home power outages and other occasional purposes.

Comparison of Rechargeable Cell Types

Table 1 is a quick comparison of the capabilities of the most popular rechargeable cell types. Included in this chart is the popular "Gel Cell," a sealed lead-acid type.

Figure 7 is a graph showing the ability of cell types to provide high levels of discharge current versus the energy storage capacity of each cell. As can be noticed, although Li-ion is rated to have lots of capacity, this is not the case under high discharge conditions, such as during transmit mode in an H-T. Note that only NiCd, NiMH and Li-ion are depicted on the graph. Lead-acid and rechargeable alkaline are in classes by themselves.

Making an Intelligent Choice

Handheld Transceiver

The first step is to decide what is important to you. Do you want minimum battery weight and lots of power regardless of the cost, and are willing to sacrifice battery life? Or perhaps you are located in northern

Table 1

Comparison of Types of Cell Chemistries

	Nickel Cadmium	*Nickel Metal Hydride*	*Sealed Lead Acid (Gel Cell)*	*Lithium-Ion*	*Reusable Alkaline*
Energy density (watt-hours per kilogram)	40-60	60-80	37	100	80 (initial)
Cycle life	1500	500	200-300	500-1000	10
Self discharge, % per month	20	30	5	10	0.2
Maximum load current	Greater than 2C	0.5-1C	0.2C	Less than 1C	0.2C

Table Glossary

Energy density—Stored energy versus weight. The higher the number, the more total energy available.

Cycle life—The approximate theoretical number of charge/discharge cycles which the cell can sustain before its energy storage capacity degrades to a specific level (about 60%). Many factors influence this figure, including the depth of discharge, average temperature, etc.

Self discharge—The amount of stored energy lost per month with the cell lying unused.

Maximum load current—The amount of discharge current that the cell can provide without significant terminal voltage drop. This is an indicator of the cell's internal resistance. Note: "C" is the cell's ampere-hour rating which is stated by the manufacturer as a 10 hour discharge rate.

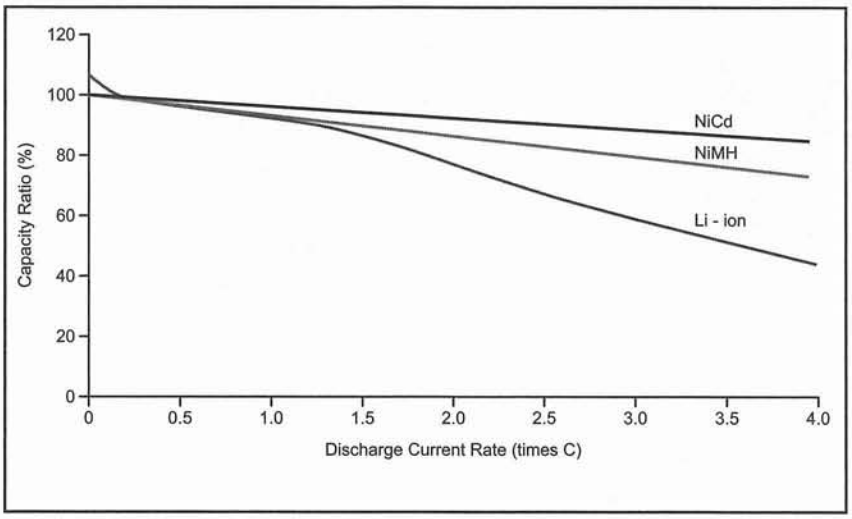


Figure 7—The graph shows capacity ratio percentage versus discharge current rate.

climates where you need a battery that will still pump out the watts even if the temperature is sub-zero. Maybe you need a battery that has the capability to sit in a ready state for many months, that you can just "grab and go." Or how about a battery that is a good compromise? Let's look at the options.

If you are an avid hiker, biker or camper, you will appreciate something which gives minimum size and weight without compromising performance. Lithium-ion is what you will want. With the highest energy density of all types of rechargeables, it will be comfortable to carry or pack. Expect to pay a higher price, however, for replacement batteries and a shortened lifetime. Lithium is also top choice for emergency standby use since it has a low self-discharge rate, and is therefore going to have more energy available when called upon for action after a lengthy period of sitting idle.

Nickel cadmium has the edge for cold weather operation as well as having the lowest internal resistance. It allows you to put out the maximum RF watts in the coldest extremes. Cost is also relatively low, and it has the highest charge/discharge cycle capability and lifetime of all types, meaning that it is a battery which will stay with you for a long time.

Emergency Shack Power

The leader here is still the lead acid. Whether you opt for the classic top-cap battery or the sealed gel cell type, the charging and maintenance is similar. If the battery is going to be inside the house, the sealed unit is the optimum choice due to its cleanliness and minimal gas evolution. Also, if it gets knocked over, there is no safety issue from spilled acid. Expect to pay more at the time of purchase, however. If the shack is basement or garage located, a deep cycle variety of marine or golf cart battery is possible. These are cheaper than the sealed variety and easier to find (see Figure 8).

Whichever type you choose, don't make the mistake of using a cheap automotive charger. Make sure that the charger is of the automatic variety, preferably one that has two or three charging states such as bulk charge, current limited, and float (by the way, a small 7-A power supply from Astron or similar manufacturer is good substitute for maintaining a charged battery, but it will not bring it to a fully charged state).

Getting the Most Life from your Battery

Nickel Cadmium and Nickel Metal Hydride

These cell types are so similar in chemistry that they can be considered together.

First, remember that both of these cell types tend to lose their stored energy quickly with time. NiCds should be recharged about once every two months, and NiMH cells about once every 4-6 weeks if they are to be kept in a ready state. Another thing is that these chemical powerhouses are like human muscles—both need exercise to retain their capability. If you use your H-T a lot, like every day or two, the battery is getting all the exercise it needs; but if your radio sits on the shelf unused, the battery can get lax and weak. If this is the case, fire up your H-T once a month and give it a day or two of good usage followed by a generous recharge afterwards. It's like a shot of vitamins.

Don't, however, allow the battery to fully discharge. To do so means that one or more cells will discharge first and will be pushed into a reverse charged state. When that happens, the cell can generate gas from the breakdown of electrolyte, which will vent into the air. The cell is robbed of some of its capability as a result and will be even more likely to reverse charge again. A basic rule of thumb is *never* let the battery discharge to the point where the "battery low" indicator comes on, since this indicates that one or more cells have already been subjected to reverse charging.

Sealed Lead Acid

The SLA cell has requirements that are different from the NiCd and NiMH cells. Whereas the NiCd and NiMH cells don't mind being in a partially charged state (or even fully discharged, as long as they haven't been reverse charged), the SLA must be kept in a near full charge condition continuously for best life and en-

ergy content. These batteries should be recharged frequently or kept on a float charge (note the reference to a small voltage regulated power supply in a preceding paragraph). The problem of plate sulphation, capable of destroying the unit, can occur if the battery becomes fully discharged for a length of time. Maintain your battery near full charge for the best life and service.

Lithium-ion

The lithium-ion is the closest of the group to being a no maintenance cell. The only real concern is overcharging, and that is usually prevented by a charge maintenance system either built into the battery pack or contained externally. Self discharge is also less than the other types, and a recharge once every two or three months should suffice.

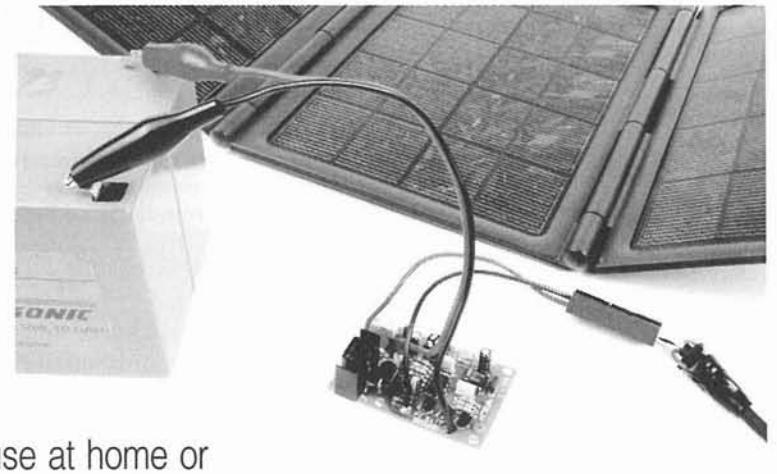
Figure 8—This type of marine deep-cycle battery can be discharged hundreds of times.

I hope this article has provided a little insight into what's going on in that little package of power in your hand or on the shack floor. If you follow the tips on charging and maintenance, your portable equipment will be ready to serve you fully on a moment's notice.

A power systems design engineer for the last 40 years, Ken Stuart, W3VVN, has developed equipment for spacecraft and deep ocean environments as well as airborne and shipboard. He has served as ARRL Technical Advisor and lecturer on power supplies and batteries since 1980, and has held a ham license continuously since 1953. Ken presently works for Lockheed Martin in Baltimore. You can reach Ken at 1235 Hillcreek Rd, Pasadena, MD 21122, **w3vvn@arrl.net**.

By Mike Bryce, WB8VGE

The Micro M+ Charge Controller



Current capacity of up to 4 A, positive line switching so all grounds tie together, standby current of less than 1 mA and more features make the Micro M+ the ideal photovoltaic charge controller for use at home or in the field. It's an easy-to-build, one-evening project that just about anyone can master.

he Micro M proved a very popular project.[1] It seems hams really do like to operate their rigs from solar power while in the outback. Many hams find solar power to be very addictive. I had dozens of requests for information on how to increase the current capacity of the original Micro M controller. The original Micro M would handle up to 2 A of current. The PC board traces and blocking diode limited the design to this current capacity. I also wanted to improve the performance of the Micro M while I was at it. Because the Micro M switched the negative lead of the solar panel on and off, the negative lead of the solar panel had to be insulated from the system ground. While that's not a problem with portable use, it may cause trouble with a home station where all the grounds should be connected. Here's what I wanted to do:

- Reduce the standby current at night
- Increase current handling capacity to 4 A
- Change the charging scheme to high (positive) side switching
- Improve the charging algorithm
- Keep the size as small as possible, but large enough to build.

[1]Notes appear at end of article.

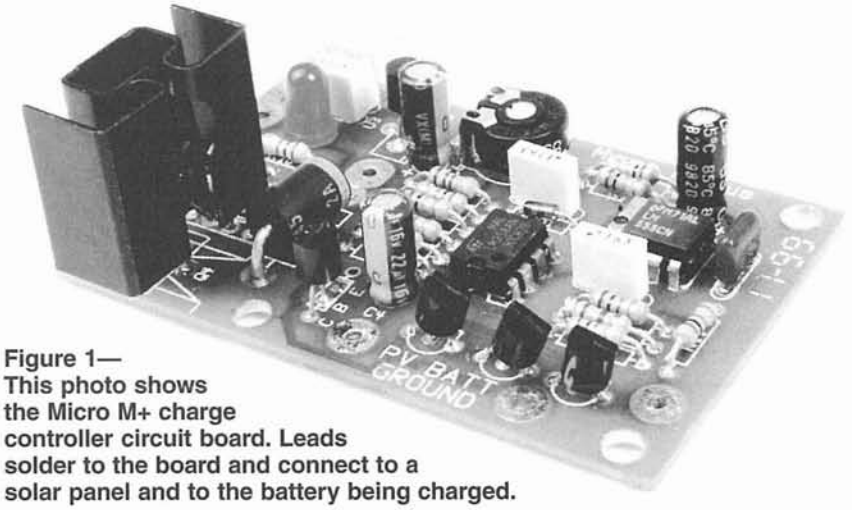


Figure 1—
This photo shows the Micro M+ charge controller circuit board. Leads solder to the board and connect to a solar panel and to the battery being charged.

The Micro M+

I called the end result the Micro M+. You can assemble one in about an hour. Everything mounts on one double-sided PC board. It's small enough to mount inside your rig yet large enough so you won't misplace it. You can stuff four of them in your shirt pocket! And, you need not worry about RFI being generated by the Micro M+. It's completely silent and makes absolutely zero RFI!

The Micro M+ will handle up to 4 A of current from a solar panel. That's equal to a 75-W solar panel.[2] I've reduced the standby current to

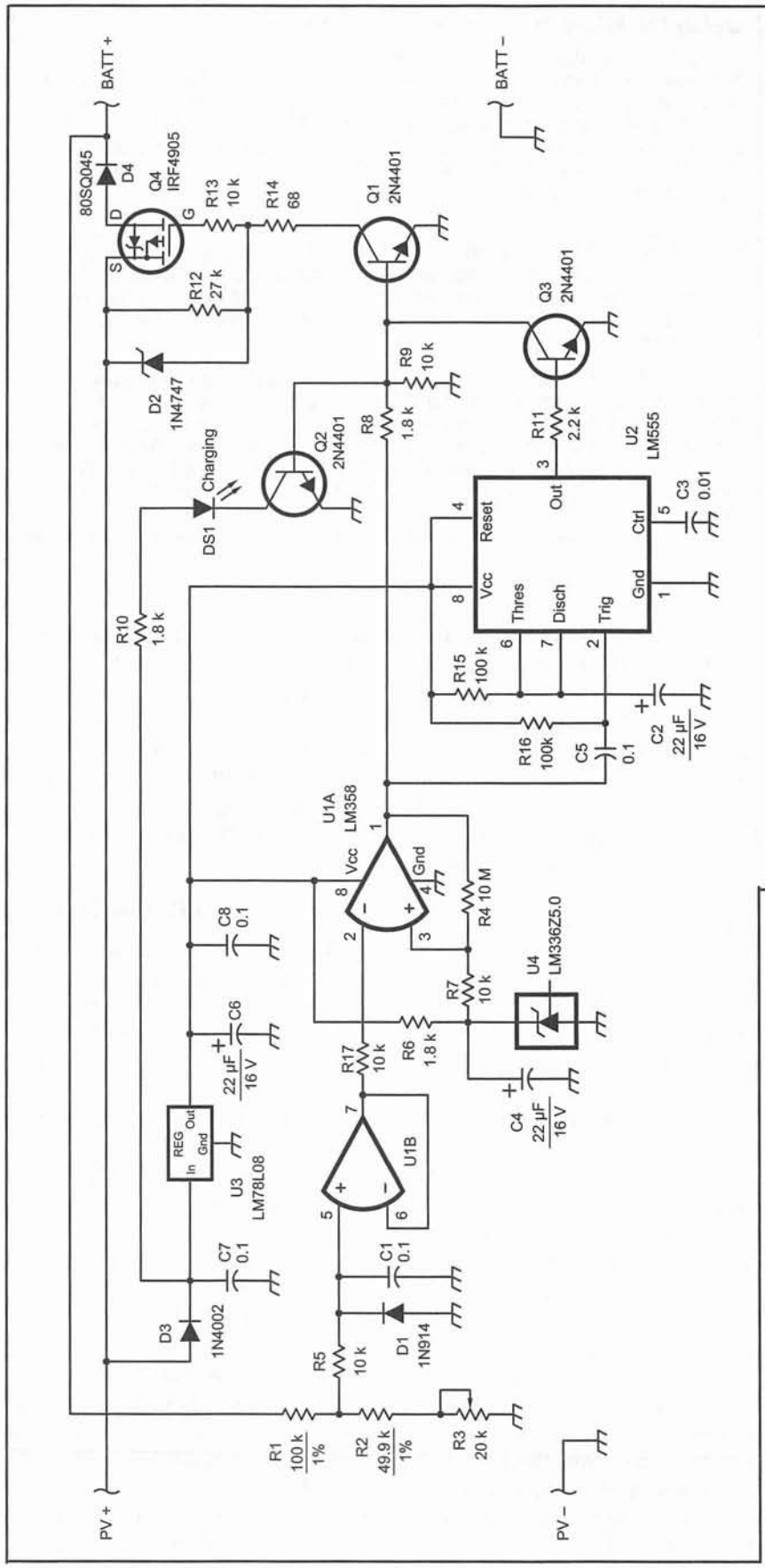


Figure 2—The schematic diagram of the Micro M+ charge controller.
C1, C5, C7, C8—0.1 µF.
C2, C4, C6—22-µF, 16-V electrolytic.
C3—0.01 µF.
D1—1N914, small signal silicon switching diode.
D2—1N4747, 20-V, 1-W Zener.
D3—1N4002, silicon rectifier diode.
D4—80SQ045, 45-V, 8-A Schottky diode.
DS1—LED, junkbox variety.
Q1, Q2, Q3—2N4401 NPN small-signal transistor (2N2222 or 2N3904 will also work).
Q4—IRF4905 P-channel MOSFET in TO-220 case. You will also need a small clip-on heat sink for this case.
R1—100 kΩ, 1%.
R2—49.9 kΩ, 1%.
R3—20-kΩ trimmer.
U1—LM358AN, dual op-amp.
U2—LM555AN timer.
U3—LM78L08, 8-V regulator.
U4—LM336Z-5.0, 5.0-V Zener diode in TO-92 case. The adjust terminal allows control of the temperature coefficient and voltage over a range. The adjust terminal is not used for the Micro M+.

less than 1 mA. I've also introduced a brand new charging algorithm to the Micro M+. All the current switching is done on the positive side. Now, you can connect the photovoltaic (PV) array, battery and load grounds together.

A complete kit of parts is available as well as just the PC board. The complete kit, including the PC board and all parts is $30.[3] The Micro M+ is easy to build, making it a perfect first-time project.

Here's How it Works

Figure 1 shows the complete Micro M+, while Figure 2 shows the schematic diagram. Let's begin with the current handling part of the Micro M+. Current from the solar panel is controlled by a power MOSFET. Instead of using a common N-channel MOSFET, however, the

Micro M+ uses an International Rectifier IRF4905 P-channel MOSFET. This P-channel FET has a current rating of 64 A with an RDS_{on} of 0.02 Ω. It comes in a TO-220 case. Current from the solar panel is routed directly to the MOSFET source lead.

N-channel power MOSFETs have very low RDS_{on} and even lower prices. To switch current on and off in a high side application, the gate of an N-channel MOSFET must be at least 10 volts higher than the rail it is switching. In a typical 12-volt system, the gate voltage must be at least 22 volts to ensure the MOSFET is turned completely on. If the gate voltage is less than that required to fully enhance the MOSFET, it will be almost on and somewhat off (the MOSFET is operating in its linear region). The device will be destroyed at high current.

To produce this higher gate voltage, some sort of oscillator typically is used to charge up a capacitor via a voltage doubler. This charge pump generates harmonics that may ride on the dc flowing into the battery under charge. Normally, this would not cause any problem, and in most cases, a filter or two on the dc bus will eliminate most of the harmonics generated. Even the best filter won't get rid of all the harmonics, however. To compound the problem, long wire runs to and from the solar panels and batteries act like antennas.

The P-channel MOSFET eliminates the need for a charge pump altogether. To turn on a P-channel MOSFET, all we have to do is pull the gate lead to ground! Since the Micro M+ does not have a charge pump, it generates *no RFI*!

Now, you may be wondering, if the P-channel MOSFET is so great, why have you not seen them in applications like this before? The answer is twofold. First, the RDS_{on} of a P-channel MOSFET has always been much higher than its N-channel cousin. Several years ago, a P-channel MOSFET with an RDS_{on} of 0.12 ohms was considered very low. At that time an N-channel MOSFET had an RDS_{on} of 0.009 ohms. Suppose you want to control 10 A of current from your solar panel. Using the N-channel MOSFET above we find the MOSFET will dissipate less than a watt of power. On the other hand, the P-channel MOSFET will dissipate 12 W of power! Current generated by our solar panels is way too expensive to have 12 W of it go up as heat from the charge controller.

The second factor was price. The P-channel MOSFET I described above would have sold for $19 each. The N-channel would have been a few dollars.

The Micro M+ never draws current from the battery. The solar panel provides all the power the micro M+ needs.

In the last year or so the RDS_{on} of the P-channel MOSFET has fallen to 0.028 ohms. The price, while still a bit on the steep side, has dropped to about $8 each.

With the P-channel MOSFET controlling the current, diode D4—an 80SQ045 Schottky—prevents current from the battery from flowing into the solar panel at night. This diode also provides reverse polarity protection to the battery in the event you connect the solar panel backwards. This protects the expensive P-channel MOSFET.

Zener diode D2, a 1N4747, protects the gate from damage due to spikes on the PV line. Resistor R12 pulls the gate up, ensuring the power MOSFET is off when it is supposed to be.

The Micro M+ Likes to Sleep

The Micro M+ never draws current from the battery. The solar panel provides all the power the Micro M+ needs. At night, the Micro M+ goes to sleep. When the sun rises, the Micro M+ will start up again. As soon as the solar panel is producing enough current and voltage to start charging the battery, the Micro M+ will pass current into the battery.

To reduce the amount of standby current, diode D3 passes current from the solar panel to U3, the voltage regulator. U3, an LM78L08 regulator, provides a steady + 8 V to the Micro M+ controller. Bypass capacitors C6, C7 and C8 are used to keep everything happy. As long as the solar panel is producing power, the Micro M+ will be awake. At sundown, the Micro M+ will go to sleep. Sleep current is on the order of less than 1 mA.

Using the Micro M+ with the Yaesu FT-817

With the introduction of the new Yaesu FT-817 all mode, all band QRP transceiver, more and more of us will be using solar power in the field. The Micro M+ was designed to use a 12-V solar panel to charge a 12-V battery. The Yaesu FT-817 can operate from 12 V supplied externally or from an internal 9.6-V NiCd battery. The NiCd battery may be charged when the battery is installed in the radio. Or, if you want, it can be charged separately from the 817 via a solar panel and the Micro M+ controller.

To use the Micro M+ to charge this NiCd pack, you'll have to change the value of resistor R2 from 49.9 kW 1% to 82.5 kW 1%. This will allow the logic to switch correctly at 11.6 V, the voltage of a fully charged 9.6-V NiCd battery. This assumes you use the standard of 1.45 V per NiCd cell. With the new value for R2, there's plenty of adjustment in the state-of-charge trimmer to allow you to fine-tune the state-of-charge.

Since the NiCd battery is rated at only 9.6 V, this throws the power point of the solar panel in the trash. A typical 5-W solar panel is rated at 290 mA at 17.1 V. Because of the lower battery voltage, there will be more than the 290 mA of current flowing. However, if the panel is designed to produce 5 W, that's all it will do. As the voltage goes down, the current will increase, up to the Isc (current short circuit) of the panel. The panel will not produce any more current than it was designed for.

Battery Sensing

The battery terminal voltage is divided down to a more usable level by resistors R1, R2 and R3. Resistor R3, a 20-kΩ trimmer, sets the state-of-charge for the Micro M+. A filter consisting of R5 and C1 helps keep the input clean from noise picked up by the wires to and from the solar panel. Diode D1 protects the input of the op-amp in the event the battery sense line were connected backward.

An LM358 dual op-amp is used in the Micro M+. One section, U1B, buffers the divided battery voltage before passing it along to the voltage comparator, U1A. Here the battery sense voltage is compared to the reference voltage supplied by U4. U4 is an LM336Z-5.0 precision diode. To prevent U1A from oscillating, a 10-MW resistor is used to eliminate any hysteresis.

As long as the battery under charge is below the reference point, the output of U1A will be high. This saturates transistors Q1 and Q2. Transistor Q2 conducts and lights LED DS1, our CHARGING LED. Q1, also fully saturated, pulls the gate of the P-channel MOSFET to ground. This effectively turns on the FET and current flows from the solar panel into the battery via D4.

As the battery begins to take up the charge, its terminal voltage will increase. When the battery reaches the state-of-charge set point, the output of U1A goes low. With Q1 and Q2 now off, the P-channel MOSFET is turned off, stopping all current into the battery. With Q2 off, the CHARGING LED goes dark.

Since we have basically eliminated any hysteresis in U1A, as soon as the current stops, the output of U1A pops back up high again. Why? Because the battery terminal voltage will fall back down as the charging current is removed. If left like this, the Micro M+ would sit and oscillate at the state-of-charge set point.

To prevent that from happening, an LM555 timer chip, U2, monitors the output of U1A. As soon as the output of U1A goes low, this low trips U2. The output of U2 goes high, fully saturating transistor Q3. With Q3 turned on, it pulls the base of Q1 and Q2 low. Since both Q2 and Q1 are now deprived of base current, they remain off.

With the values shown for R15 and C2, charging current is stopped for about four seconds after the state-of-charge has been reached.

After the four second delay, Q1 and Q2 are allowed to have base drive from U1A. This lights up the charging LED and allows Q4 to pass current once more to the battery.

As soon as the battery hits the state-of-charge once more, the process is repeated. As the battery becomes fully charged, the "on" time will shorten up while the "off" time will always remain the same four seconds. In effect, a pulse of current will be sent to the battery that will shorten over time. I call this charging algorithm "Pulse Time Modulation."

As a side benefit of the pulse time modulation, the Micro M+ won't go nuts if you put a large solar panel onto a small battery. The charging algorithm will always keep the off time at four seconds allowing the battery time to rest before being hit by higher current than normal for its capacity.

Building Your Own Micro M+

There's nothing special about the circuit. The use of a PC board makes the assembly of the Micro M+ quick and easy. It also makes it much easier if you need to troubleshoot the circuit. You can build the entire circuit on a piece of perf-board if you want.

The power MOSFET must be protected against static discharges. A dash of common sense and standard MOSFET handling procedures will work best. Don't handle the MOSFET until you need to install it in the circuit. A wrist strap would be a good idea to prevent static damage. Once installed in the PC board, the device is quite robust.

A small clip-on heat sink is used for the power MOSFET. If you desired, the MOSFET could be mounted to a metal chassis. If you do this, make sure you insulate the MOSFET tab from the chassis.

If you plan on using the Micro M+ outside, then consider soldering the IC directly onto the board. I've found that cheap solder-plated IC sockets corrode. If you want to use an IC socket, use one with gold-plated contacts.

Feel free to substitute part values. There's nothing really critical. I do suggest you stick with 1% resistors for both R1 and R2. This isn't so much for the close tolerance, but for the 50-PPM temperature compensation they have. You can use standard off-the-shelf parts for either or both R1 and R2, but the entire circuit should then be located in an environment with a stable temperature.

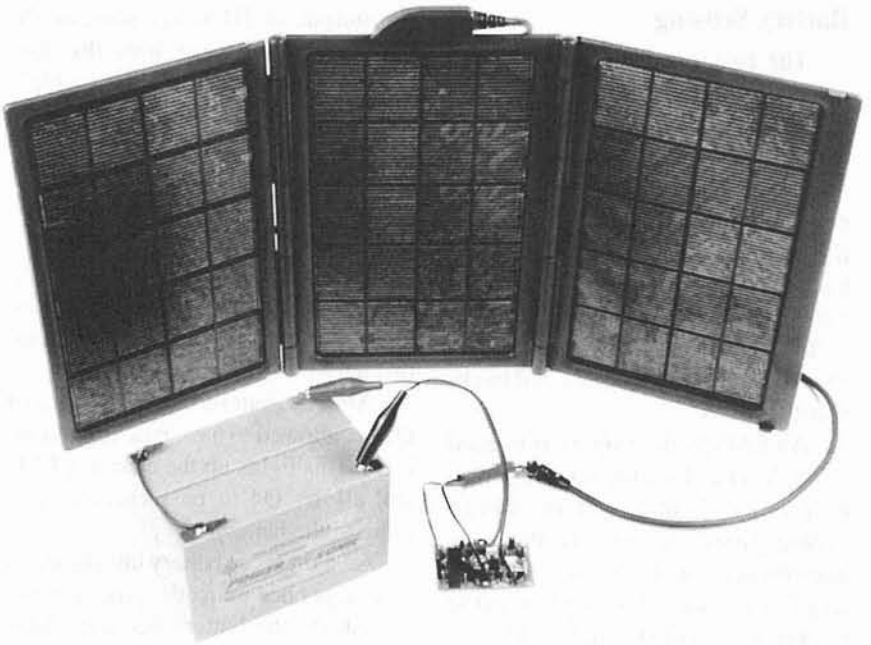
Adjustments

You'll need a good digital voltmeter and a variable power supply. Set the power supply to 14.3 V. Connect the battery negative and power supply negative leads together at a circuit-board ground point. Connect the PV positive and battery positive lead, and the power supply positive leads together. The charging LED should be on. If not, adjust trimmer R3 until it comes on. Check for +8 V at the V_{cc} pins of the LM358 and the LM555. You should also see + 5 V from the LM336Z5.0 diode.

Quickly move the trimmer from one end of its travel to the other. At one point the LED will go dark. This is the switch point. To verify that the "off pulse" is working, as soon as the LED goes dark quickly reverse the direction of the trimmer. The LED should remain off for several seconds and then come back on. If everything seems to be working, it's time to set the state-of-charge trimmer.

Now, slowly adjust the trimmer until the LED goes dark. You might want to try this adjustment more than once as the closer you get the com-

parator to switch at exactly 14.3 V, the more accurate the Micro M+ will be. Here's a hint I've learned after adjusting hundreds of Micro M+ controllers. Set the power supply to slightly above the cutoff voltage you want. If you want 14.3 V, then set the supply to 14.5 V. I've found that in the time it takes to react to the LED going dark, you overshoot the cutoff point. Setting the supply higher takes this into account and usually you can get the trimmer set to exactly what you need in one try. That's all you need to do. Disconnect the supply from the Micro M+ and you're ready for the solar panel.



The Micro M+ Charge Controller board, small enough to mount inside your rig, is shown connected to a solar panel and a rechargeable battery.

Odds and Ends

The 14.3-V terminal voltage will be correct for just about all sealed and flooded cell lead-acid batteries. You can change the state-of-charge set point if you want to recharge NiCds or captive sealed lead-acid batteries.

Keep the current from the solar panel within reason for the size of the battery you're going to be using. If you have a 7-amp hour battery, then don't use a 75-W solar panel. You'll get much better results and smoother operation.

The tab of the power MOSFET is electrically hot. If you plan on using the Micro M+ without a protective case, make sure you insulate the tab from the heat sink. A misplaced wire touching the heat sink could cause real damage to both the Micro M+ and your equipment. A small plastic box from RadioShack works great.

More Current?

Well yes, you can get the Micro M+ to handle more current. You must increase the capacity of the blocking diode and mount the power MOSFET on a larger heat sink. I've used an MBR2025 diode and a large heat sink for the MOSFET and can easily control 12 A of current.

Battery Charging Without a Solar Panel?

Yes, that's possible, too. The trick is to use a power supply for which you can limit the output current. A discharged lead acid battery will draw all the current it can from the charging source. In a solar panel setup, if the panel produces 3 A, that's all it will do. With an ac powered supply, the current can be excessive. To use the Micro M+ with an ac powered supply, set the voltage to 15.5 V. Then limit the current to 2 or 3 A.

No matter if you're camping in the outback, or storing photons just in case of an emergency, the Micro M+ will provide your battery with the fullest charge. The Micro M+ is simple to use and completely silent. Just like the sun!

Notes

[1]"The Micro M," Sep 1996 *QST*, p 41.

[2]A 75-W module produces 4.4 A at 17 V. The Micro M+ can easily handle the extra 400 mA.

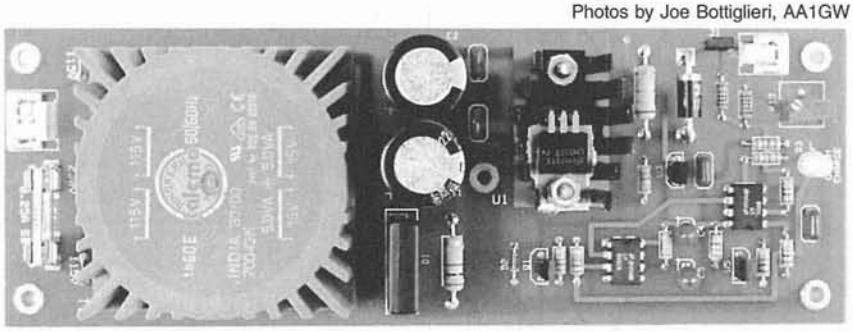
[3]A complete kit of parts is available from SunLight Energy Systems, 955 Manchester Ave SW, North Lawrence, OH 44666. A complete kit including all parts and PC board is $30 plus $4 US Priority mail. Visa, MasterCard accepted. Tel 330-832-3114; **www.seslogic.com/**.

By Bob Lewis, AA4PB

An Automatic Sealed-Lead-Acid Battery Charger

This nifty charger is just what you need to keep your SLA batteries up to snuff!

Photos by Joe Bottiglieri, AA1GW



After experiencing premature failure of the battery in my Elecraft K2 transceiver (most likely because I forgot to keep the battery on a regular charge schedule), I began searching for an *automatic* battery charger.[1, 2] The K2 uses a Power-Sonic PS-1229A 12-V, 2.9-Ah sealed lead-acid (SLA) battery. SLAs are commonly called *gel-cells* because of their gelled electrolyte. As with all things, to obtain maximum service life from an SLA battery, it needs to be treated with a certain degree of care. SLA batteries must be recharged on a regular basis; they should not be undercharged or overcharged. If an SLA battery is left unused, it will gradually self-discharge.

Although my SLA battery experiences related here are linked to my K2 transceiver, you can think of the K2 simply as a load for the battery. The comments pertaining to the SLA batteries and chargers apply across the board and the charger described here can be used with any similar battery.

Using a Three-Mode Charger

My first attempt at keeping my K2's SLA battery healthy was to purchase an automatic three-mode charger. I soon discovered that most three-mode chargers work by sensing current and were never intended to charge a battery under load.

Three-mode chargers begin the battery charging process by applying a voltage to the battery through a 500-mA current limiter. This stage is known as *bulk-mode* charging. As the battery charges, its voltage begins to climb. When the battery voltage reaches 14.6 V, the charger maintains the voltage at that level and monitors the battery charging current. This is known as the *absorption mode*, sometimes called the *overcharge mode*. By this time, the battery has achieved 85% to 95% of its full charge. As the battery continues to charge—with the voltage held constant at 14.6 V—the charging current begins to drop. When the charging current falls to 30 mA, the three-mode charger switches to *float mode* and lowers the applied voltage to 13.8 V. At 13.8 V, the battery becomes self-limiting, drawing only enough current to offset its normal self-discharge rate. This works greatæuntil you attach a light load to the battery, such as turning on the K2 receiver. The K2 receiver normally draws about 220 mA. When the charger detects a load current above 30 mA, it's fooled into thinking that the battery needs charging, so it reverts to the absorption mode, applying 14.6 V to the battery. If left in this condition, the battery is overcharged, shortening its service life.

UC3906-IC Chargers

Chargers using the UC3906 SLA charge-controller IC work just like the three-mode charger described earlier except that their return from float mode to absorption mode is based on voltage rather than current. Typically, once the charger is in float mode it won't return to absorption mode until the battery voltage drops to 10% of the float-mode voltage (or about 12.4 V). Although this is an improvement over the three-mode

[1]Notes appear at end of article.

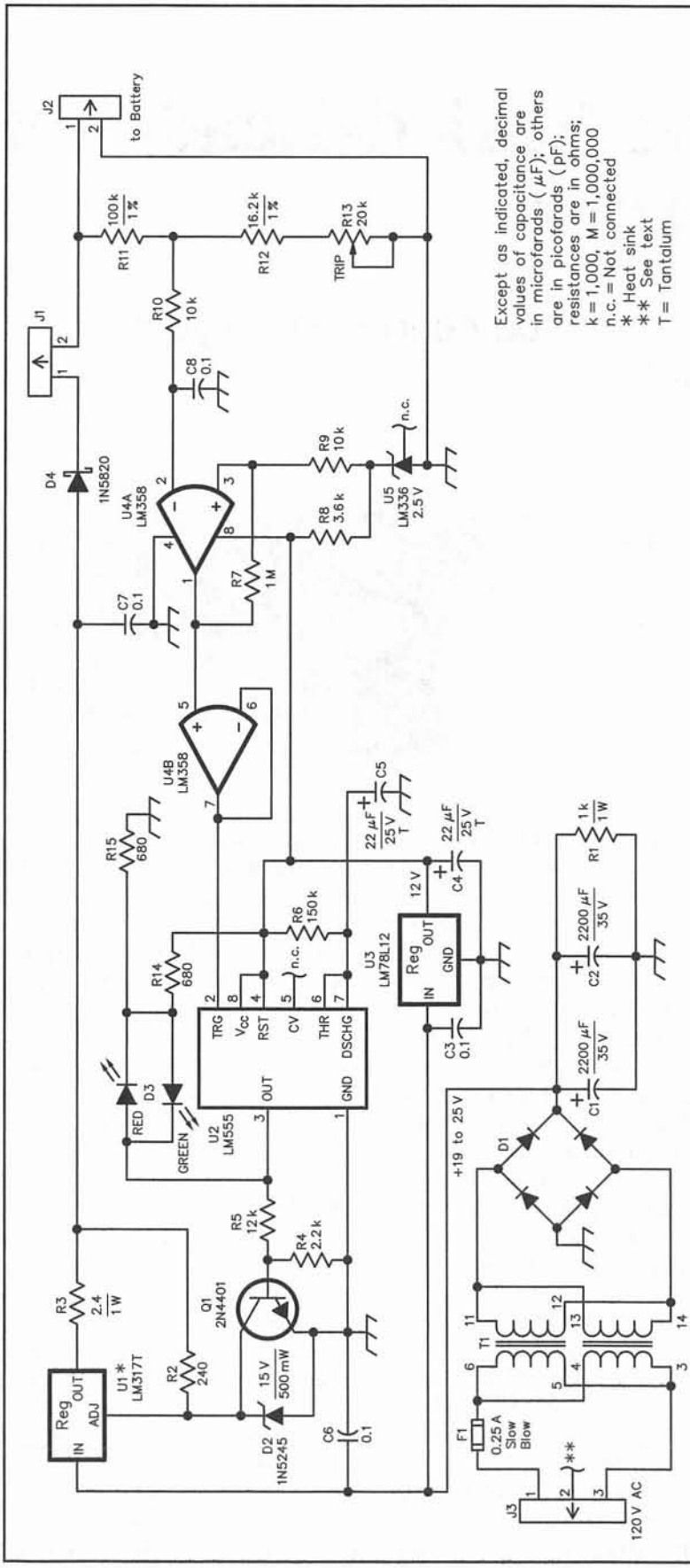


Figure 1—Schematic of the SLA charger. Unless otherwise specified, resistors are 1/4-W, 5%-tolerance carbon-composition or metal-film units. Part numbers in parentheses are Digi-Key (Digi-Key Corp, 701 Brooks Ave S, Thief River Falls, MN 56701-0677; tel 800-344-4539, 218-681-6674, fax 218-681-3380; www.digikey.com). Equivalent parts can be substituted; n.c. indicates no connection. (The component designations for D1, D3 and J1 differ from *QST* style.)

C1, C2—2200 μF, 35 V electrolytic (P5751)
C3, C6, C7, C8—0.1 μF, 50 V metallized-film (104) (P4525)
C4, C5—22 μF, 25 V tantalum (P2051)
D1—400 V, 4 A bridge rectifier (KBL04)
D2—1N5245 Zener diode, 15 V, 500 mW (1N5245BDICT)
D3—Bicolor LED, red/green (160-1036)
D4—1N5820 Schottky diode (1N5820DICT)
F1—0.25 A slow-blow fuse (283-2267)
J1—2-pin header, PC mount (S1011-02)
J2—2-pin connector, PC mount (WM5224)
J3—3-pin connector, PC mount (WM5225)
Q1—2N4401 NPN transistor (2N4401)
R1—1 kΩ, 1 W, 5% (1.0 KW-1)
R2—240 Ω (240QBK)
R3—2.4 Ω, 1 W, 5% (2.4W-1)
R4—2.2 kΩ (2.2KQBK)
R5—12 kΩ (12KQBK)
R6—150 kΩ (150KQBK)
R7—1 MΩ (1.0MQBK)
R8—3.6 kΩ (3.6KQBK)
R9, R10—10 kΩ (10KQBK)
R11—100 kΩ, 1/4 W, 1% (100KXBK)
R12—16.2 kΩ, 1/4 W, 1% (16.2KXBK)
R13—20 kΩ multiturn pot (3296Y-203)
R14, R15—680 Ω (680QBK)
T1—15 V ac, 666 mA (TE70043)
U1—LM317T voltage regulator, TO-220 case (LM317T)
U2—LM555 timer (LM555CN)
U3—LM78L12 voltage regulator, TO-92 case (NJM78L12A)
U4—LM358 dual op amp (LM358N)
U5—LM336, 2.5 V voltage reference, TO-92 case (LM336Z-2.5NS)

Misc: PC board (see Note 3); TO-220 heat sink (294-1036); five 1/4-inch, #4-40 stand-offs (1892K); two fuse-holder clips, PC mount (283-2335); two-pin shunt (S9002); two-pin connector housing (WM2111); three-pin connector housing (WM2112); four housing pins (WM2305); enclosure

charger, it still has the potential for overcharging a battery to which a light load is attached.

First, let's look at the situation where a UC3906-controlled charger is in absorption mode and you turn on the K2 receiver, applying a load. The battery is fully charged, but because the load is drawing 220 mA, the charging current never drops to 30 mA and the charger remains in absorption mode, thinking that it is the battery that is asking for the current. As with the three-mode charger, the battery is subject to being overcharged.

If we remove the load by turning off the K2, the current demand drops below 30 mA and the charger switches to float mode (13.8 V). When the K2 is turned on again, because the charger is able to supply the 220 mA for the receiver, the battery voltage doesn't drop, so the charger stays in float mode and all is well. However, if the transmitter is keyed (increasing the current demand), the charger can't supply the required current, so it's taken from the battery and the battery voltage begins to drop. If we unkey the transmitter before the battery voltage reaches 12.4 V, the charger stays in float mode. Now it takes much longer for the charger to supply the battery with the power used during transmit than it would have if the charger had switched to absorption mode.

Let's key the transmitter again, but this time keep it keyed until the battery voltage drops below 12.4 V. At this point, the charger switches to the absorption mode. When we unkey the transmitter, we're back to the situation where the charger is locked in absorption mode until we turn off the receiver.

Why Worry?

So, why this concern about overcharging an SLA battery? At 13.8 V, the battery self-limits, drawing only enough current to offset its self-discharge rate (typically about 0.001 times the battery capacity, or 2.9 mA for a 2.9 Ah battery). An SLA battery can be left in this float-charge condition indefinitely without overcharging it. At 14.6 V, the battery takes more current than it needs to offset the self-discharge. Under this condition, oxygen and hydrogen are generated faster than they can be recombined, so pressure inside the battery increases. Plastic-cased SLA batteries such as the PS-1229A have a one-way vent that opens at a couple of pounds per square inch pressure (PSI) and release the gases into the atmosphere. This results in drying the gelled electrolyte and shortening the battery's service life. Both undercharging and overcharging need to be avoided if we want to get maximum service life from the battery.

Continuing to apply 14.6 V to a 12-V SLA battery represents a relatively minor amount of overcharge and results in a gradual deterioration of the battery. Applying a potential of 16 V or excessive bulk-charging current to a small SLA battery from an uncontrolled solar panel can result in serious overcharging. Under these conditions, the overcharging can cause the battery to overheat, which causes it to draw more current and result in thermal runaway, a condition that can warp electrodes and render a battery useless in a few hours. To prevent thermal runaway, the maximum current and the maximum voltage need to be limited to the battery manufacturer's specifications.

Design Decision

To avoid the potential of overcharging a battery with an automatic charger locked up by the load, I decided to design my own charger, one that senses battery voltage rather than current in order to select the proper charging rate. A 500-mA current limiter sets the maximum bulk rate charge to protect the battery and the charger's internal power supply. Like the three-mode chargers, when a battery with a low terminal voltage is first connected to the charger, a constant current of 500 mA flows to the battery. As the battery charges, its voltage begins to climb. When the battery voltage reaches 14.5 V, the charger switches off. With no charge current flowing to the battery, its voltage now begins to drop. When the current has been off for four seconds, the charger reads the battery voltage. If the potential is 13.8 V or less, the charger switches back on. If the voltage is still above 13.8 V, the charger waits until it drops to 13.8 V before turning on. The result is a series of 500-mA current pulses varying in width and duty cycle to provide an average current just high enough to maintain the battery in a fully charged condition. Because the repetition rate is very low (a maximum of one current pulse every four seconds) no RFI is generated that could be picked up by the K2 receiver. Because the K2's critical circuits are all well regulated, slowly cycling the battery voltage between 13.8 V and 14.5 V has no ill effects on the transmitted or received signals.

As the battery continues to charge, the pulses get narrower and the time between pulses increases (a lower duty cycle). Now when the K2 receiver is turned on and begins drawing 220 mA from the battery, the battery voltage drops more quickly so the pulses widen (the duty cycle increases) to supply a higher average current to the battery and make up for that taken by the receiver. When the K2 transmitter is keyed, it draws about 2 to 3 A from the battery. Because the charger is current limited to 500 mA, it is not able to keep up with the transmitter demands. The battery voltage drops and the charger supplies a constant 500 mA. The battery voltage continues to drop as it supplies the required transmit current. When the transmitter is unkeyed, the battery voltage again begins to rise as the charger replenishes the energy used during transmit. After a short time, (depending on how long the transmitter was

keyed) the battery voltage reaches 14.5 V and the pulsing begins again. The charger is now fully automatic, maintaining the battery in a charged condition and adjusting to varying load conditions.

The great thing about this charging system is that during transmit the majority of the required 2 to 3 A is taken from the battery. When you switch back to receive, the charger is able to supply the 220 mA needed to run the receiver and deliver up to 280 mA to the battery to replenish what was used during transmit. This means that the power source need only supply the average energy used over time, rather than being required to supply the peak energy needed by the transmitter. (You don't need to carry a heavy 3-A regulated power supply with your K2.) As long as you don't transmit more than about 9% of the time, this system should be able to power a K2 indefinitely.

Have you ever noticed that sometimes when your H-T has a low battery and you drop it into its charger you hear hum on the received signals? This charger's power supply is well filtered to ensure that there is no ripple or ac hum to get into the K2 under low battery voltage conditions.

Circuit Description

The charger schematic is shown in Figure 1. I've dubbed the charger the PCR12-500A, short for Pulsed-Charge Regulator for 12-V SLA batteries with maximum bulk charge rates of 500 mA. U1, an LM317 three-terminal voltage regulator, is used as a current limiter, voltage regulator and charge-control switch. A 15-V Zener diode (D2) sets U1 to deliver a no-load output of 16.2 V. R3 sets U1 to limit the charging current to 500 mA. When Q1 is turned on by the LM555 timer (U2), the **ADJ** pin of U1 is pulled to ground, lowering its output voltage to 1.2 V. D4 effectively disconnects the battery by preventing battery current from flowing back into U1. A Schottky diode is used at D4 because of its low voltage drop (0.4 V).

An LM358 (U4A) operates as a voltage comparator. U5, an LM336, provides a 2.5-V reference to the positive input (pin 3) of U4. R11, R12 and R13 function as a voltage divider to supply a portion of the battery voltage to pin 2 of U4A. R13 is adjusted so that when the battery terminal voltage reaches 14.5 V, the negative input of U4A rises slightly above the 2.5-V reference and its output switches from +12 V to 0 V. When this happens, the 1-MW resistor (R7) causes the reference voltage to drop a little and provide some hysteresis. The battery voltage must now drop to approximately 13.8 V before U4A turns back on.

U4B is a voltage follower. It pulls the trigger input (pin 2) of U2 to 0 V, causing its output to go to 12 V. U4B's output remains at 12 V until C5 has charged through R6 (approximately four seconds) *and* the trigger has been released by U4A sensing the battery dropping to 13.8 V or less. While the output of U2 is at 12 V, emitter/base current for Q1 flows via R5 and Q1's collector pulls U1's **ADJ** pin to ground, turning off the charging current.

The output of U2 also provides either +12 V or 0 V to the bicolor LED, D3. R14 and R15 form a voltage divider to provide a reference voltage to D3 such that D3 glows red when U2's output is +12 V and green when U2's output is at 0 V. When ac power is applied but U1 is switched off and not supplying current to the battery, D3 glows red. When U1 is on and supplying current to the battery, D3 is green. As the battery reaches full charge, D3 blinks green at about a four-second rate. As the battery charge increases, the *on* time of the green LED decreases and the *off* time increases. A fully charged battery may show green pulses as short as a half-second and the time between pulses may be 60 seconds or more.

T1, D1, C1 and C2 form a standard full-wave-bridge power supply providing an unregulated 20 V dc at 500 mA. U3, an LM78L12 three-terminal regulator, provides a regulated 12-V source for the control circuits.

Note that the mounting tab on U1 is not at ground potential. U1 should be mounted to a heat sink with suitable electrically insulated but thermally conductive mounting hardware to avoid short circuits. Suitable mounting hardware is included with the PC board (see Note 4).

Other Bulk-Charge Rates

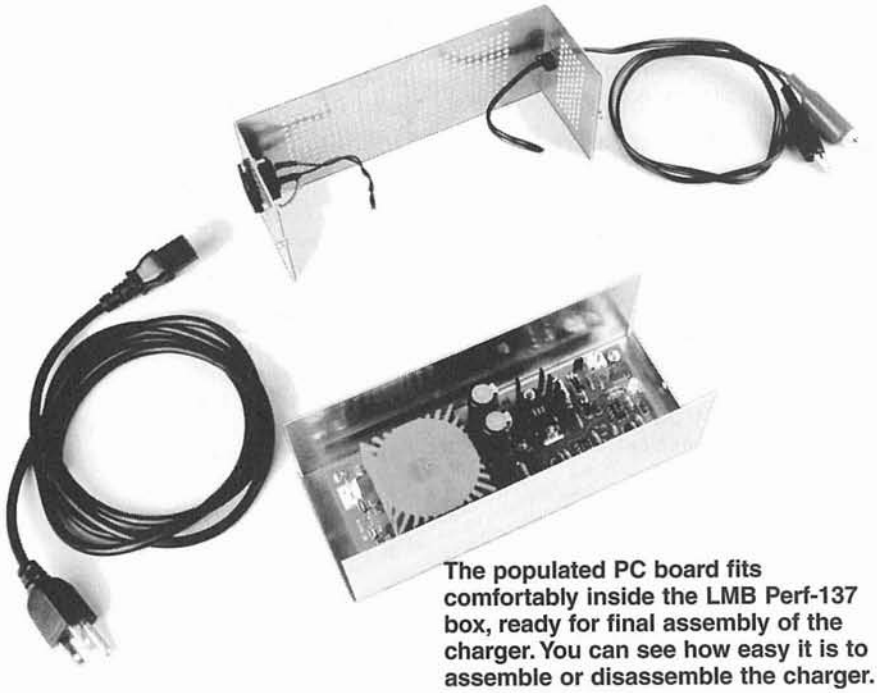
The maximum bulk-charge rate is set by the value of R3 in the series regulator circuit. The formula used to determine the value of this resistor is $R_{ohms} = 1200 / I_{mA}$. T1 must be capable of supplying the bulk charge current and U1 must be rated to handle this current. The LM317T used here is rated for a maximum current of 1.5 A *provided* it has a heat sink sufficiently large enough to dissipate the generated heat. If you increase the bulk-charge rate, you'll definitely need to increase the size of the on-board heat sink. Mounting U1 directly to the housing (be sure to use an insulator) may be a good option.

Transformer Substitution

I selected T1 because of its small size and PC-board mounting. You can substitute any transformer rated at 15 or 16 V ac (RMS) at 500 mA or more. You may find common frame transformers to be more readily available. You can mount such a transformer to an enclosure wall and route the transformer leads to the appropriate PC-board holes.

Construction

There is nothing critical about building this charger. You can assemble it on a prototyping board, but a PC board and heat sink are available.[4] The specially ordered heat sink supplied with the PC board is $^1/_4$-inch higher than the one identified in the parts list and results in slightly cooler operation of U1. The remaining parts



The populated PC board fits comfortably inside the LMB Perf-137 box, ready for final assembly of the charger. You can see how easy it is to assemble or disassemble the charger.

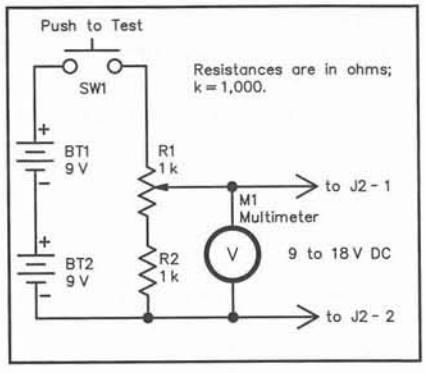


Figure 2—Test voltage source for the battery charger. (The component designation for the push-button switch differs from *QST* style.)

are available from Digi-Key.

Be sure to space R1 and R3 away from the board by $^1/_4$ inch or so to provide proper cooling. R13 can be a single-turn or a multiturn pot. You'll probably find a multiturn pot makes it easier to set the cutoff voltage to exactly 14.5 V.

R13 Adjustment

To check for proper operation and to set the trip point to 14.5 V dc, we need a test-voltage source variable from 12 to 15 V dc. A convenient means of obtaining this test voltage is to connect two 9-V transistor-radio batteries in series to supply 18 V as shown in Figure 2. Connect a 1-kΩ resistor (R2) in series with a 1-kΩ potentiometer (R1) and connect this series load across the series batteries with the fixed-value resistor to the negative lead. The voltage at the pot arm should now be adjustable from 9 to 18 V. During the following procedure, be sure to adjust the voltage *with the test supply connected to the charger at J2* because the charger loads the test-voltage supply and causes the voltage to drop a little when it's connected.

Remove the jumper at J1 and apply ac line voltage to the unit at J3. Turn R13 fully counterclockwise. D3 should glow green. Connect the test voltage to J2 and adjust R1 of Figure 2 for an output of 14.5 V. Slowly adjust R13 clockwise until D3 glows red. To test the circuit, wait at least four seconds, then gradually reduce the test voltage until D3 turns green. At that point, the test voltage should be approximately 13.8 V. Slowly increase the test voltage again until D3 turns red. The test voltage should now read 14.5 V. If it is not exactly 14.5 V, make a minor adjustment to R13 and try again. The aim of this adjustment is to have D3 glow red just as the test voltage reaches 14.5 V.

To test the timer functioning, remove the test voltage from J2 and set it for about 15 V. Momentarily apply the test voltage to J2. D3 should turn red for approximately four seconds, then turn green. The regulator is now calibrated and ready for operation. Remove the test voltage and ac power and install the jumper at J1.

A Suitable Enclosure

I used an 8×3×2.75-inch LMB Perf-137 box (Digi-Key L171-ND) to house the charger. An alternative enclosure is the Bud CU482A Convertabox, which measures 8×4×2 inches (available from Mouser). If you use the Convertabox, be sure to add some ventilation holes directly above the board-mounted heat sink. The LMB Perf box comes with a ventilated cover. If you are inclined to do some metal work, you could build your own enclosure using aluminum angle stock and sheet and probably reduce the size to perhaps 8×3×2 inches. If you use a PC-board-mounted power transformer, watch out for potential shorts between the transformer pins (especially the 120-V ac-line pins) and the case. If you use a metal enclosure, connect the safety ground (green) wire of the ac-line cord directly to the case.

Operation

It is very important that this charger be connected *directly* to the SLA battery with no diodes, resistors or other electronics in between the two. The charger works by reading the battery voltage, so any voltage drop across an external series component results in an incorrect reading and improper charging. For example, the Elecraft K2 has internal diodes in the power-input cir-

cuit, so it's necessary to add a charging jack to the transceiver that provides a direct connection to the battery. Now I can leave my K2 connected to the charger at all times and be assured that its internal battery is fully charged and ready to go at a moment's notice.

Notes

[1]Larry Wolfgang, WR1B, "Elecraft K2 HF Transceiver Kit," Product Review, *QST*, Mar 2000, pp 69-74.

[2]Although this charger was designed specifically for use with the Power-Sonic PS-1229A SLA battery used in the Elecraft K2 transceiver, its design concepts have wide ranging applications for battery operated QRP rigs of all types.

[3]Although it's labeled a 12-V battery, the terminal voltage is nominally 13.8 V with no load.

[4]A PC Board (double sided, plated through holes, solder masked and silk screened) and heat sink are available from Intelligent Software Solutions, PO Box 522, Garrisonville, VA 22463-0522. Price: $18 plus $1.50 shipping in the US and Canada.

Bob Lewis, AA4PB, became interested in Amateur Radio during junior high school in the late '50s. With the encouragement of his cousin, Al Krugler, K8DDX, Bob obtained his Technician license (K8KNI) and spent most of his time on 6-meter AM in the Detroit, Michigan area. His early interest in Amateur Radio resulted in a career in electronics, first as a radio mechanic in the air-transport industry, followed by ten years in the Navy as an aviation electronics technician. While in the Navy, Bob found 6-meter activity to be a bit sparse in the middle of the Atlantic Ocean, so he upgraded to General, then Advanced and finally, Extra class. He enjoys QRP, PSK31 and home-brewing. Bob is retired from Civil Service, currently working part-time for an electronics consulting firm. You can contact him at Box 522, Garrisonville, VA 22463; **rlewis@staffnet.com**.

By Kirk A. Kleinschmidt, NTØZ

How to Choose and Use a Portable Power Generator

June—Field Day month—gives us a great excuse to operate from woods, mountain peaks or jungles (concrete or otherwise) in an age-old exercise to improve our emergency communication skills. But what about electrical power? If you're operating "off the grid," a portable generator may be just what you need. Here's some practical advice about choosing the right generator and using it safely.

Setting up a radio station at the local park and working stations here, there and everywhere with a bunch of your best radio buddies is what makes Field Day special. That, and the beer, hamburgers or whatever you're serving in your neck of the radio woods. In addition to a weekend of fun and camaraderie, we improve our ability to serve the public in times of need—and our operating skills probably inch up a notch or two as well.

If you're new to this game you may be wondering about how everything is powered. And even if your operating site has electrical power (campground, softball park, courthouse lawn, etc), you may not want to avail yourself of its convenience. Field Day is ostensibly about practicing for communication emergencies when the ac mains might be out of commission.

Common power sources include batteries, vehicle alternators, wind-powered alternators, solar panels and engine-driven portable power generators. And speaking of portable power generators (PPGs for short), we see them at golf courses, in hardware stores and on TV news reports during floods and ice storms—but we don't see much about them in Amateur Radio publications!

I hope this article gives you a leg up on choosing and using the right portable power generator for your applications, Field Day or otherwise. Pay special attention to the safety issues. Generators—like all engine-powered devices—can injure or even kill you if you don't respect them. And unlike your garden tractor, these powerhouses can *electrocute* you (or others). Don't be afraid—but do pay attention!

The most basic units have preset throttle/engine speeds that can be adjusted to match required loads. These are most useful for powering incandescent lights or small ac motors (saws, drills, etc), which can safely tolerate "cruddy power." Use them to power solid-state devices at your own risk!

Because there are no free lunches, PPGs that offer better regulation and greater output power cost more money. Units that have little or no automatic regulation and less capacity are more affordable—unless you're talking about the tiny "hand-held" units that weigh in at 25 to 60 pounds, which cost more than some higher-powered, beefier, standard models!

And as if that's not enough, in addition to power capacity and regulation, there are other factors to consider such as engine type, noise level, fuel options, fuel tank capacity, run time, size, weight, cost, connectors, miscellaneous bells and whistles, etc.

Buying a Portable Power Generator

Before you run down to your local hardware superstore and buy the first PPG that catches your eye, consider the following items in light of

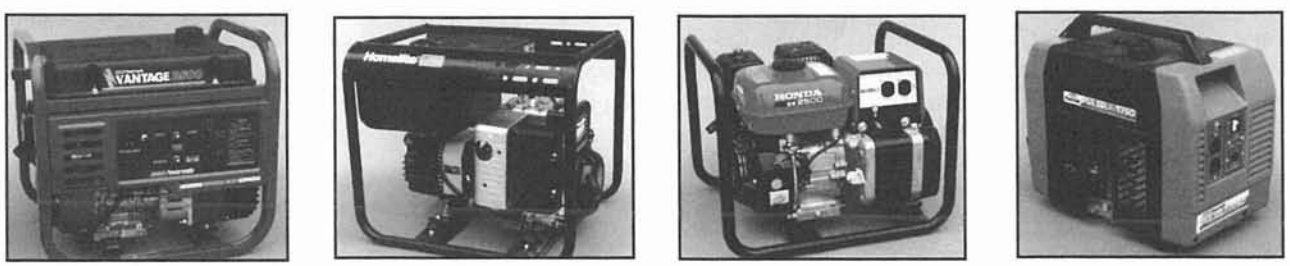


Figure 1—The author tested these four portable power generators during the creation of this article. See Table 1 and the "Resources" sidebar for more information. (All photos by the author)

your personal requirements. Sure, you'll use the generator for Field Day, but don't forget to factor in other possible uses such as camping, power outages, and so on. Try to do some research of your own. Your exact requirements may vary, and you may need a solution that fits.

The generators we're discussing here are designed for consumers, contractors and farmers. They're designed for occasional use, not for continuous, long-term applications. Units designed for continuous service and ultra-reliability (for marine, medical and telecommunication systems) are available through specialty suppliers, but the prices are prohibitive for casual users.

PPGs powered by diesel, kerosene, propane and natural gas are also available (at similarly high prices), as are ultra-quiet, liquid cooled, and specially sized and shaped generators. The PPGs we'll be considering are air-cooled and powered by gasoline. The four PPGs I tested while writing this article are shown in Figure 1.

Capacity

To be useful, your generator must be able to safely power all of the devices that will be attached to it. On a basic level that's just common sense. Simply add up the power requirements of *all* the devices, add a reasonable safety margin (25 to 30%) and choose a suitably powerful generator that meets your other requirements.

When you read the fine print, however, things get tricky. Some devices—most notably motors—take a lot more power to start up than they do to keep running. For example, a motor that takes 1000 W to run may take 2000 to 3000 W to start. Light bulbs, soldering irons, space heaters and most radios don't require extra start-up power, but be sure to plan accordingly.

Size and Weight

PPG size and weight usually vary according to power output—low-power units are lightweight and physically small, while beefier models are larger and weigh more. See Table 2 for more details. Some models are wrapped in a large protective frame while others have less "air space" inside the "cage."

Tiny camper models (800 to 1000 W output) are amazingly small and lightweight, but some units lack sufficient regulation and may not be recommended for powering solid-state devices. On the other hand, some teeny gens can put out a whopping 70 A of 12-V dc for charging batteries. If your gear is battery-powered, you may still be in luck.

Engines and Fuel

Most portable generators are driven by small gasoline engines similar to those used to power lawnmowers or go-carts. Basic models are powered by standard side-valve engines. These often make more noise, need more-frequent servicing and often don't live very long. More expensive models have overhead-valve (OHV) engines, pressure lubrication, low-oil shutdown, cast-iron cylinder sleeves, oil filters and electronic ignition systems. These features may be overkill if your generator will be used only occasionally. But if your generator needs are more consistent, "upgrade" models may offer much better service.

Run Time

Let's face it: Filling the generator's gas tank every hour can be a hassle—especially if you do it safely by shutting off the engine and letting it cool briefly before carefully pouring in more gas.

As a rule, smaller PPGs have smaller gas tanks (and vice versa)—but that doesn't necessarily mean that they need more frequent refueling. Some small engines are more efficient than their larger counterparts and may run for half a day while powering small loads.

When you look at generator specs, remember that the run times for most units are shown for 50% loads. If you're running closer to max capacity, your run times may be seriously degraded. The opposite is also true. "Extended Run" models usually have more efficient engines and larger gas tanks. The generator unit, however, is usually unchanged.

Typical PPGs run from three to nine hours on a full tank of gas at a 50% load.

Figure 2—Prized by RVers, PowerWatch Technologies' *Good Governor* is a handy unit that visually indicates ac wiring faults and accurately displays the voltage and frequency of the ac line source it's plugged into. If you can't find one at your local RV dealership, contact the manufacturer at PO Box 22988, Denver, CO 80222.

Noise

Subject to a few exceptions, generators are almost always too loud. That is, we'd always prefer them to be less obvious. If you're set up for Field Day way out in the woods, generator noise probably isn't a problem. If you're set up in a campground or other more-public space, however, PPGs can sound like a rock concert. Keeping the things quiet isn't always possible!

Noise levels for many models are stated right on the box, but because there's no set standard for measuring generator noise, take these with a grain of salt and try to test them yourself before buying.

Was the PPG three feet away

from the sound level meter, or was it 10 or 20? Was the muffler facing the test set, or was it hiding behind the unit's engine? Did the noise tests take place in an open field, or were buildings or other reflective structures nearby? You get the idea!

That said, some models are definitely quieter than others. Some gens *do* have quieter engines and muffler systems, but most of the noise is actually produced by rotating generator parts and vibrating sheet metal. If you take great pains to make the exhaust quieter—as some users attempt—you may be shocked to discover that your improved "stealth generator" is only marginally less noisy!

Water-cooled PPGs (rare and somewhat expensive) produce less noise, as do units designed to be housed in special compartments found in boats and RVs. They're not a free lunch, though. RV gens are expensive and heavy.

Regulation

As previously mentioned, voltage and frequency regulation—or lack thereof—may significantly influence your buying decision. The bottom line is that *any* PPG can safely power lightbulbs, heating elements and power saws, but when it comes to computers, TVs and expensive ham radios, units with mechanical or electronic regulation may be required, if only for peace of mind! (All of the gens I tested safely powered solid-state devices. Initial tests, however, were made with a small TV set I'd purchased for $5 at a garage sale, just to be sure!)

Unloaded generators may put out 130 V at 62-63 Hz. As loads increase, frequency and voltage decrease. Under full load, output values may fall as low as 105 V at 58-59 Hz. Normal operating conditions are somewhere in between.

To add an extra measure of safety, consider inserting an uninteruptable power supply (UPS) or a line conditioner between the generator and your sensitive gear. These devices are often used to maintain steady, clean ac power for computers and telecommunication equipment. As the mains voltage moves up and down, a line conditioner bucks or boosts accordingly. UPSs, with internal gel-cell batteries, provide power to the load if the ac mains (or your generator) go down.

If "electronic voltage regulation" isn't mentioned on the box, consider calling the manufacturer before you buy. And although you might get lucky, don't expect expert help from the salesperson at your local hardware store—they're used to helping contractors who want to power lights and saws. (To improve your odds of getting a unit with electronic regulation, consider buying a PPG intended for sale in Canada. Two manufacturers suggested that all Canadian PPGs must have electronic regulation.)

Dc Output

Some PPGs have 12-V dc outputs for charging batteries. These range from 2-A trickle chargers to 100-A powerhouses. Typical outputs run about 10 to 15 A. As with the ac outputs, be sure to test the dc outputs for voltage stability (under load if possible) and ripple. Batteries—especially when your car is stranded in a blizzard—aren't too fussy about a little ripple in the charging circuit, but your radio might not like it at all! It's better to be safe than sorry.

Miscellaneous

Other considerations include outlets (120 V ac, 240 V ac, 12 V dc, etc), circuit breakers (standard or GFCI), fuel-level gauges, handles (one or two), favorite brands, starters (pull or electric), engine operating speeds (faster means more noise, less weight and a shorter lifespan, and vice versa), wheels, handles or

Table 1
Measurements and Data from the PPGs Shown in Figure 1

Model	*Output Surge & Cont*	*Run Time @ 50% load (hours/gals)*	*V/f @ 0 W 500 W 1000 W*	*Reg. Method*	*Engine Type & Size*	*Weight (lb)*	*Price (Street)*	*Notes*
Coleman Vantage 3500	4375 3500	9/3	128/63 125/62 125/62	Elect.	OHV 5.5 hp	110	$1049	1,2,3,4 5,6,8,9
Coleman Pulse 1750	1750 1400	5/0.9	133/63 130/62 125/60	None	Std 3 hp	65	$499	1,2,5,7,9
Homelite LR2500	2500 2300	7.2/3	157/64 151/64 149/64	Mech	Std 5 hp	87	$479	2,5,9
Honda EZ2500A	2500 2300	2.6/1	124/63 122/61 119/60	Elect.	OHV 5.5 hp	81	$789	5,6,7,8,9

1—Has 15-A, 12-V dc output.
2—"Extended Run" model.
3—Unit intended for sale in Canada.
4—Engine automatically idles when no loads are attached.
5—Unit has low-oil shutdown.
6—Unit has electronic ignition.
7—Unit is physically compact.
8—Unit is noticeably quieter than typical units in its class.
9—Unit should be adjusted for best voltage and frequency before regular use.

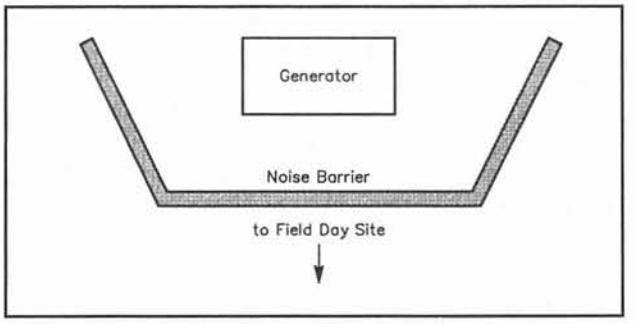


Figure 3—A two- or three-sided "room divider"-style noise shield is a handy, low-tech way to put a barrier between you and your Field Day generator. Use cardboard or carpet-covered plywood (with hinges, perhaps?), but don't put the generator in a covered box!

Resources

If you can't find a decent selection of PPGs at your local hardware superstore (with the Y2K craze, PPGs are in short supply everywhere), call Northern Hydraulics (800-533-5545) or Harbor Freight Tools (800-423-2567) and request catalogs. They're handy for other items, too!

For more information on the generators I mention in this article, surf or call: Honda generators, **www.honda-generators.com/generators/index.html**; Coleman generators, 800-445-1805; Home-lite generators, **www .homelite.com/homelite/products/**.

For information on UPSs, line conditioners and inverters, start with Statpower (**www.statpower.com/home.htm**) and American Power Conversion (APC) **www .apcc.com/**.

whatever you require.

Using Your Generator

Before we can connect "real" electrical loads in a Field Day situation we need to choose a grounding method—a real controversy among campers, RVers and home-power enthusiasts.

To complicate matters, almost all PPGs have ac generator grounds that are connected to the units' metal frames, but some units do not "bond" the ac neutral wires to the ac ground wires (as is done in typical house wiring). Although they might safely power your ham station all day long, units with "unbonded neutrals" may appear defective if tested with a standard outlet "polarity" tester.

Some users religiously drive copper ground rods into the ground or connect the metal frames of their generators to suitable existing grounds, while others vigorously oppose this method and let their gens float with respect to earth ground. Some user manuals insist on the ground connection, while others don't. The same is true for various electrical codes.

Follow the instructions in your user's manual and comply with local electrical codes. Grounding can also be a consideration with respect to lightning protection. See the ARRL Technical Information Service package on lightning-protection methods at **www.arrl.org/tis/info/lightnin.html**.

Regardless of the grounding method you choose, a few electrical safety rules remain the same. Your extension cords *must* have intact, waterproof insulation, three "prongs" and three wires, and must be sized according to loads and cable runs. Use 14-16 gauge, three-wire extension cords for low-wattage runs of 100 feet or less. For high-wattage loads, use heavier 12-gauge, three-wire cords designed for air compressors, air conditioners or RV service feeds. If you use long extension cords to power heavy loads, you may damage your generator and/or your radio gear. When it comes to power cords, think *big*. Try to position extension cords so they won't be tripped over or run over by vehicles. And don't run electrical cords through standing water or over wet, sloppy terrain.

During Field Day operations, try to let all operators know when the generator will be shut down for refueling so radio and computer gear can be shut down in a civilized manner. Keep the loads disconnected at the generator until the generator has been refueled and restarted. And keep a sharp eye out for late night ops who try to sneak space heaters, leg warmers or coffee makers into the tents. An extra 1500 W of power draw can crash the generator in a hurry!

Handy Tips

Ask any Generator Elmer and you'll get a flood of helpful hints—many learned the hard way. Here are a few:

Light Bulb Load Stabilizer

To keep generator output as stable as possible when switching loads on and off (keying a transmitter, for example), try keeping a small load (two light bulbs, for example) connected for the duration. The constant load can reduce power swings while the engine governor "hunts" to maintain proper shaft speeds.

Noise Reduction

According to many trial-and error users, the best way to tame a noisy PPG during Field Day is to set it up in an out-of-the-way area and make a two- or three-sided sound shield from carpet-covered plywood or stiff cardboard (these look like small, folding room dividers). Keep the sound absorber/reflector between you and the gen. Do *not* make a four-sided shield or put the generator into any type of box. Gens need airflow to keep cool. See Figure 3.

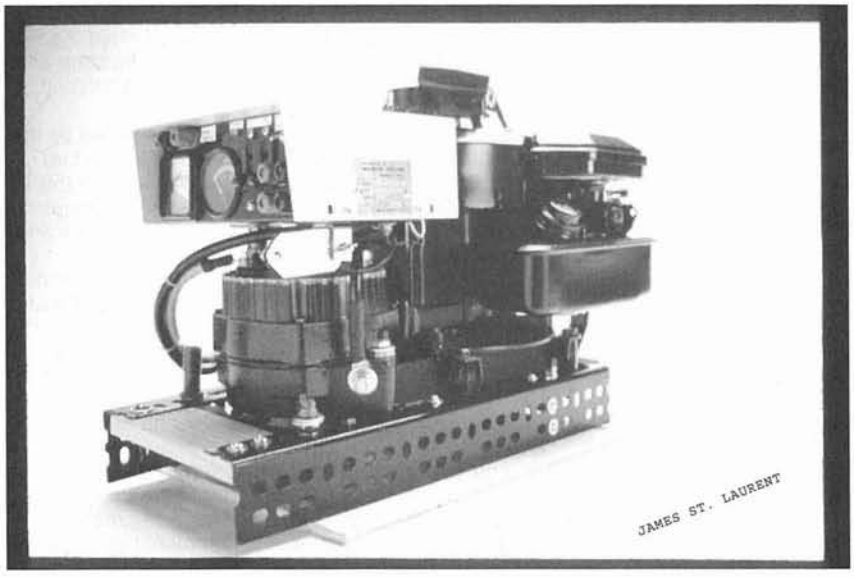
Storage

When Field Day fun is over, don't just shove your generator into a dark corner of the garage. Follow the user manual's storage procedures and consider adding a small amount of gasoline stabilizer to keep the gasoline from oxidizing and gumming up the carburetor.

By Yaniko Palis, VE2NYP

The 12 Volt Pup: A DC Generator You Can Build

Grab a lawn-mower engine and an alternator to build a great 50 A power supply for Field Day or . . .



Field Day weekend is the best event of the year! I have always loved wilderness camping and almost any other adventure in the wide-open spaces. Coincidentally, my work often involves setting up all kinds of gear at remote locations for short periods of time—sort of a large-scale version of Field Day. Because of these two interests, Field Day has been my favorite event ever since I became a ham, six years ago. Now, thanks to what I have named "The 12 Volt Pup," I can easily generate enough power to operate a 100 W transceiver and plenty of accessories at almost any location I choose.

Generating power at remote locations is burdensome, in both equipment weight and cost. The Pup weighs about 45 pounds without a battery; so one person can handle it fairly easily. All told, expect to tote anywhere between 70 and 100 pounds, including batteries, fuel, oil and cables. If needed, you can easily disassemble the Pup into assemblies weighing less than 20 pounds each for backpacking.

The 12 V Pup combines a standard 3.5 horsepower lawn mower engine with an automotive alternator. These two components mount face downward onto two parallel, heavy duty, **L**-shaped steel rails, as shown in Figure 1. Spacers between the components and the rails precisely locate the pulleys and belt within the two steel rails. (See Figure 2.) Thus, the unit can rest on any appropriate flat surface. The engine takes a pulley for standard **V** belts, which makes it compatible with the alternator. Add a car battery and presto! You're in business. This design is amazingly simple.

An emergency version of this device could be jury rigged in an hour and a half. All you really need is a pulley for the engine, the right

[1]Notes appear at end of article.

JAMES ST. LAURENT

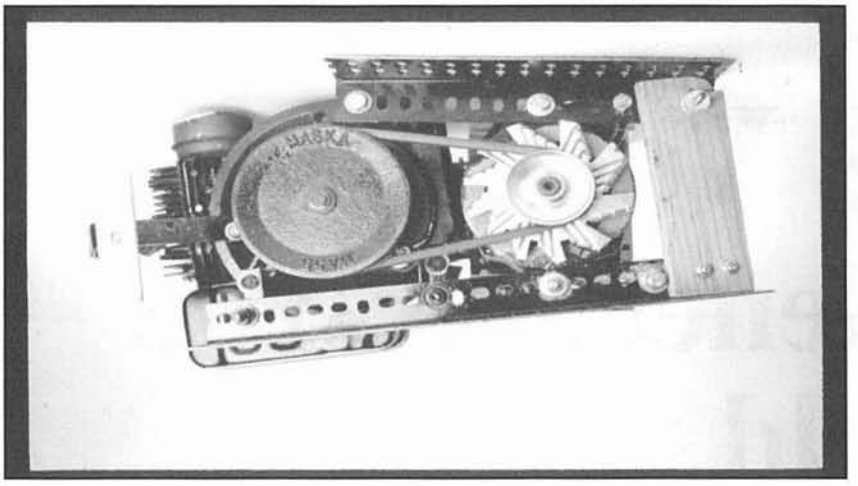


Figure 1—A bottom view without protective shields indicates the simplicity of the basic design. An engine bracket is visible at the left end of the lower (front) rail. The slot to mount the alternator (small pulley with fan) is in the upper (rear) rail. The Pup has wooden handles at each end for carrying.

JAMES ST. LAURENT

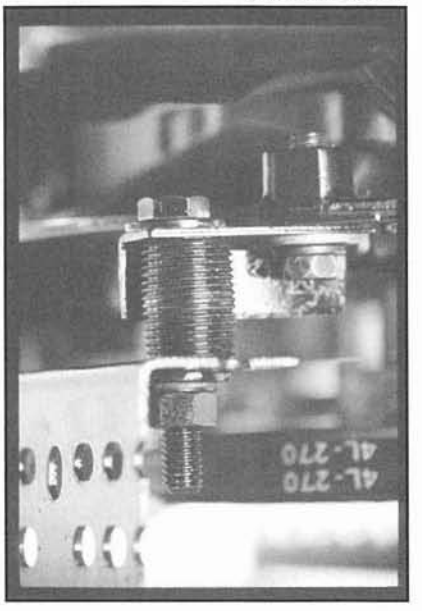


Figure 2—One of the two small engine brackets is above the pipe-coupling spacer. The engine is at the upper right, the front rail at lower left. See Figure 4 for mechanical details.

Partial Parts List for the 12 V Pup:

Motor (1)—(See Figure 4.) After searching for a used engine, I bought a new, no frills lawn mower (for $99) and kept the engine. Recent models have a safety lever connected to a **KILL** switch on the engine that grounds a *neutralizing wire* to stop the engine. This neutralizing wire connects to the control box ignition switch and protection circuit.

Alternator (1)—(See Figure 3.) The one I used is modified as suggested by the folks at a large alternator-remanufacturing company. They rewound a standard alternator with fewer turns so that its internal regulator activates more often (50 A output). A modified unit should cost $65 to $85. Any standard internally regulated alternator with an internal charge controller should be fine, especially for charging automotive batteries. (A used alternator is worth $15 to $30.)

Motor Pulley (1)—Get one sized for standard **V** belts. Its rim diameter should be twice that of the alternator's pulley. This makes the alternator turn twice as fast as the engine. I used a 5 1/2-inch-diameter pulley. It's a big blessing that the engine shaft's dimensions are standard in every way. A common steel pulley fits right onto the engine's 7/8-inch shaft and accepts a standard locking key (3/16 inch wide by 1/8 inch deep).

V Belt to fit the pulleys, likely to be somewhere between 27 and 30 inches long; see text.

Storage Battery (1)—12 V lead-acid battery, 15 Ah or greater. Automotive or motorcycle batteries work, but a deep-discharge battery that tolerates fast charging is best. (Gel cells require a closely controlled charging regimen.)*

Steel rails (2) of **L**-shaped angle iron. This material is commonly used to support heavy-duty, industrial-grade storage shelves. It is perforated with rows of holes that ease assembly, provide ventilation and reduce its weight. The flanges should be at least 2 1/4 × 1 1/2 inches. The front rail is 18 inches long; the back rail is 14 inches long.

Motor Brackets (2)—Heavy-duty 1×1-inch angle iron. See Figure 4.

Hardware (Nuts, bolts and spacers—all of which may vary):

(3) Engine-mount bolts, 3/8×16×2 1/2 inches long

(3) Spacers, 3/4-inch-diameter, 1 1/4-inches-long steel pipe couplings. These spacers place the engine pulley in the same plane as the alternator pulley. Buy longer couplings and/or shorten them as needed to accurately align the two pulleys.

(2) Alternator mounting bolts to fit your alternator.

*The regimen is described in "A New Chip for Charging Gelled-Electrolyte Batteries," by Warren Dion, N1BBH, in *QST*, Jun 1987, pp 26-29.

size belt and two angle iron rails fitted with simple little mounts. Of course, you must also be willing to critically amputate your car and lawn mower! I decided to build a dedicated unit instead; it sports a control box and it cost me only $250 for all new parts. If you can scrounge up used parts, $125 should get you all the basic ingredients. My Pup took about four days to create. It's great to use the Pup with two or more deep-discharge lead-acid batteries. You can operate with power from one battery while charging the other. Because the Pup will probably charge a battery much faster than you would normally consume the stored energy, the generator may be switched off perhaps half of the time. This conserves fuel and reduces noise pollution.

You could also connect a load directly to the generator—as long as there's a battery connected across the load to stabilize the alternator's output. The engine's little governor works just fine, readily adapting the throttle to changing load conditions. While idling, the Pup provides about 6 A for normal battery charging. A 50% throttle setting produces about 30 A and ensures proper governor performance under varying loads.

Uses for the Pup go far beyond powering radios: I have inspired a friend to make one for his remote mountain cabin; it's a reliable supplement to his solar panels. A Pup

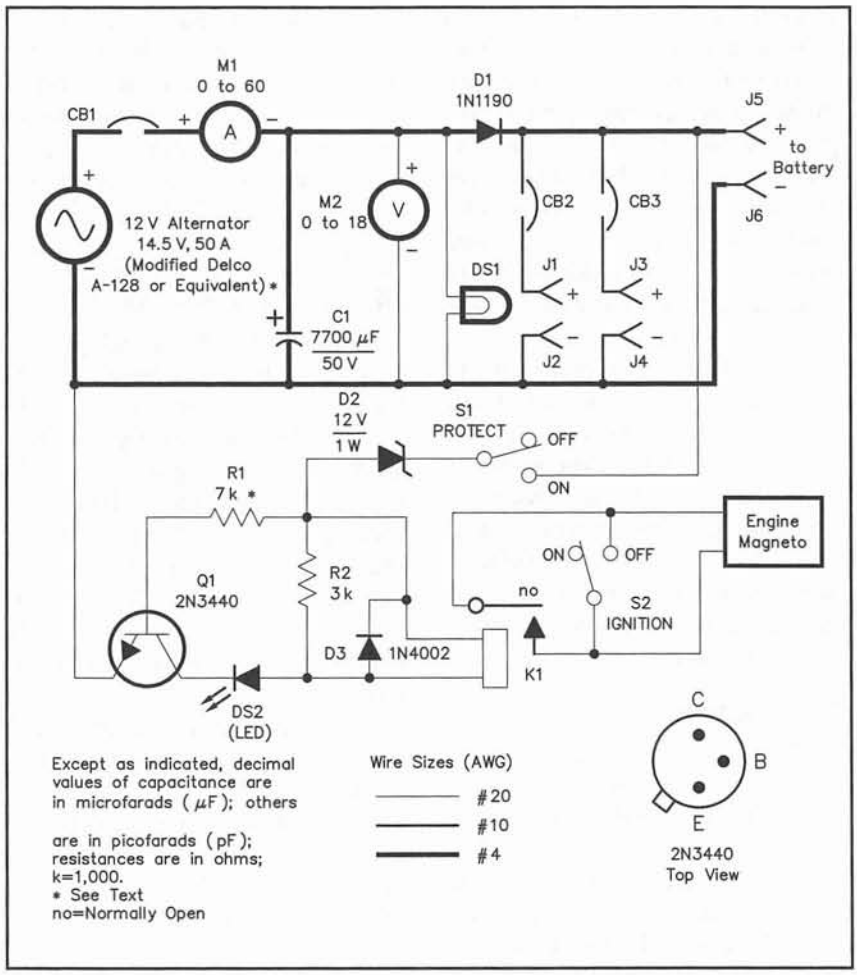


Figure 3—Control box schematic. Equivalent parts may be substituted for those shown. Many of the parts that carry large currents are not available from typical electronic-part suppliers. You'll have better luck at auto-part stores and local electrical-supply shops.

DS1—Automobile panel lamp, 12 V, 6 W, with socket and switch

C1—7700 µF, 50 V aluminum electrolytic

CB1—50 A automotive automatic-reset circuit breaker (from author's junk box; see Note 1)

CB2, CB3—30 A dc circuit breaker switches (65 V dc, 37.5 A trip, No. UPL1-1 from Philips Technologies Airpax Protector Group, 807 Woods Rd, Box 520, Cambridge, MD 21613-0520; tel 410-228-1500, fax 410-228-3456)

J1-J4—30 A terminals or connectors (builder's choice)

J5, J6—50 A terminals or connectors (builder's choice, look at your car's alternator connectors for ideas)

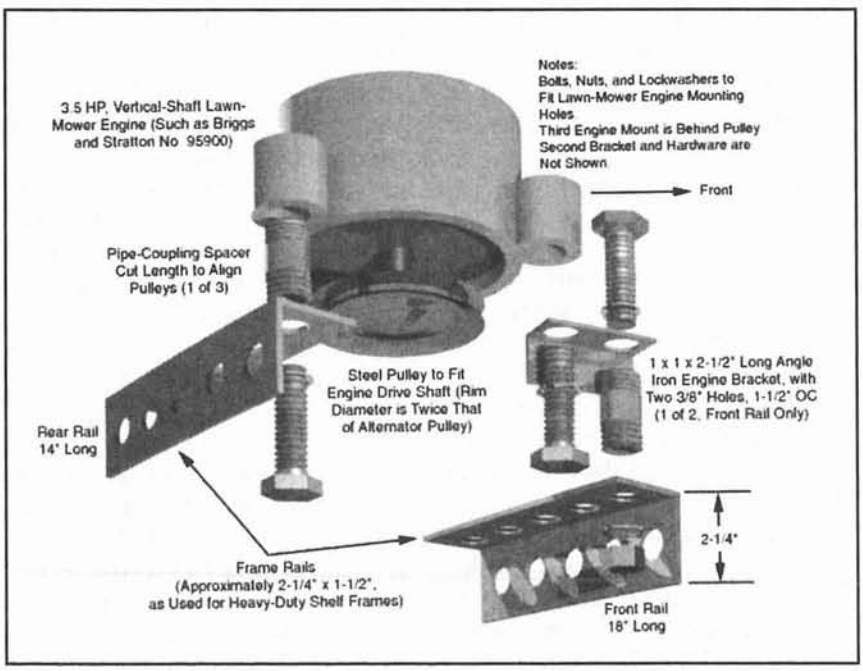


Figure 4—A pictorial of the engine mounting details.

can charge vehicle batteries in the field. The Pup is also an excellent auxiliary power unit for an RV or at the race track, for deluxe golf carts and—my most ingenious use thus far—to charge batteries for electric trolling motors. "Ahoy, mateys! Let's visit a maritime mobile, haar!" I'm sure you'll find a use for a VE2NYP 12 Volt Pup.

Voltage Regulation

Cars do not run on 12 V, and regulated alternators are inherently unstable. Without some additional regulation, even a so-called "internally regulated" alternator will likely put out ugly inductive spikes at a dangerous 20 V, or more. Without other provisions to condition the output, a sizable lead-acid battery is essential; it should stabilize the output to a ripple-free 14.5 V.

The Control Circuit

The control box that I built is very simple. (See Figure 3.) The entire circuit is protected by an internal, auto-

motive, 50 A automatic-reset circuit breaker.[1] The two auxiliary outputs are each protected by 30 A breaker switches. Even with these breakers, this system is as hazardous as that of a car: Shorting the battery, alternator or internal wiring will cause a *big* explosive spark. (They might hear it in Calcutta, but we no longer send code like this!) Carefully avoid electrical shorts at all times—*especially* when handling the battery cables.

To filter the alternator's output, I installed a 7700 mF electrolytic capacitor across it. The capacitor absorbs the output spikes, leaving a rounded reverse-ramp wave as ripple at 0.40 V (a barely tolerable 3.5%). A 6-W panel lamp acts as a minimum load that protects the battery against overcharging. D1 is a high-current blocking diode. It prevents battery discharge through the lamp and reduces the voltage at the battery to about 13.8 V. I also built a very simple protection circuit that stops the engine should the output exceed 15.5 V (16.0 V peak ac).

During its brief life as a prototype, I have already received many good suggestions on how to improve my control box. For instance, one could stay on an automotive theme and use a ballast resistor, solenoid and an ignition relay to disconnect the battery. You could use a heavy-duty headlight switch with an internal circuit breaker for the power switch.[2] All this is to say, the control-box circuit that I show here is only one of many possibilities—you're welcome to improvise!

Finally, I recommend that you study the unit's output with an oscilloscope to be certain that your valuable equipment won't be damaged if the battery is disconnected while you are running the Pup. Also, some 12 V-only devices might be damaged by the 13.8 V dc that this device normally generates. [Most equipment built for automotive use is rated to +15 V.—*Ed.*]

Potential Hazards

There are mechanical dangers from the belt, pulleys and other moving parts. It is *your* responsibility to install adequate mechanical shields to prevent bodily harm. The photos show some metal shields and a plywood base that enclose the moving parts. Cut and fit similar shields to your Pup when the main construction is done. Keep fingers, hair, clothes, etc, completely away from all moving parts.

As with all combustion-powered generators, stray sparks may ignite the fuel. Stop the engine to refuel, and don't start it again until any spills have evaporated. Keep all cables, connectors, switches and relay contacts away from the fuel tank, and use this device only in well-ventilated areas. Closely follow *all* of the engine manufacturer's warnings.

Construction

The exact configuration of your Pup will depend on the actual engine and alternator pair that you acquire. That selection will determine the control-box size limitations. (I temporarily assembled the major parts several times to determine the final arrangement.) These notes may ease your construction. A socket set, wrenches and nut drivers turn this process into a breeze. So tune in your favorite listening frequency and enjoy the pleasures of being an insatiable tinkerer.

As you build, take measures against hazards: Prevent access to moving parts; tighten and seal connections against vibration; allow engine and alternator heat to escape; provide ventilation for cables and contacts carrying high currents; plan for exposure to the weather. Use plenty of grommets, wire ties, heat-shrink tubing, hot glue and strain reliefs to render all the connections Murphy proof.

Soldered connections may melt at the current levels found in this project. I crimped—and then soldered—heavy-duty lugs onto all the cable ends. For high-current connections, I bolted the lugs to the various components and jacks. Almost any circuit that shorts in the control box will likely melt. Finally, keep in mind that your Pup will probably operate in wet environments, so paint and seal its controls and connections against rain (and fuel vapors!).

Mechanical Assembly: Be an Iron Worker in your own Home

In the following assembly notes, I call the side of my engine with the fuel tank and carburetor on it the "front." The spark plug therefore sticks out of the right side and the crankcase is on the left. The alternator is to the left of the engine, beside the crankcase. This places the alternator on the cooler side of the engine (away from the cylinder). The control box is mounted atop the alternator.

Most lawn-mower engines seem to have the same three reinforced mounting holes on their base. (See Figure 4.) Two of the three holes line up with the front, so the long rail goes there. The third hole is at the "rear" and the shorter rail bolts to it. The engine mounts—via two angle-iron brackets, bolts and spacers—to the narrow flange of each main rail; the wide flanges become the vertical sides of the Pup's base. (Refer to Figure 2.)

Before you attach the rails, assemble the two engine brackets to the two front mounting holes on the engine. Position them to point away from the engine, toward the front. These brackets create plenty of elbow room for the engine's new pulley and permit easy access to the oil drain plug. They can swivel slightly, to easily mate with existing holes on the front rail.

Temporarily install the small mounting brackets to the engine, and measure the spacer length (Figures 2 and 4) required to perfectly align the two pulleys. Attach the two main rails so that they extend toward the left as far as possible. It is advantageous that the back rail has only one engine mount because the rail can pivot to

accommodate alternators of any diameter.

My alternator did not require spacers because its two mounting holes are flush with the pulley side of its casting. The alternator's cooling fan blades scraped the edge of the rails so I trimmed the blade corners slightly. The threaded mounting hole of the alternator sits on the back rail and mounts to a slot you will cut out of the back rail later. The plain hole on the alternator casting pivots on the front rail, where it's attached. Check all clearances, and ensure once more that the two pulleys are in *perfect* alignment. Verify that the rails and spacers support the pulleys above the ground.

Now measure the arc that the alternator must swing along the back rail to accept a standard-length belt. A slot about 2 inches long allows for a $1^1/_2$-inch variation for belt size, eg, to accept *either* 28 *or* 29-inch belts. (I finished the unit before buying a belt—keep Murphy at bay, I say.) You can plan for standard-length belts during construction using the following formula:

$$BL = 1.57(D + d) + \sqrt{(D + d)^2 + 4C^2} \quad \text{(Eq 1)}$$

where

BL = Belt length (make all measurements in inches)

D = Diameter of large pulley

d = Diameter of small pulley

c = Distance between pulley centers

To use all available space, I installed the control box on simple rubber-damped mounts that I improvised. They poise the box about $1^1/_2$ inches above the alternator. This allows for air flow and protects the alternator from the rain. Once you have measured all the large internal components and cabling and have established the placement of the control box, pick a suitable cabinet and mark it for machining.

To finish, I picked a spot for a heavy-duty ground lug on the front rail. Thereafter, a few inches will remain open at the left end of the two rails. You can secure a small piece of wood to them, to grasp when lifting the Pup by its left side.

JAMES ST. LAURENT

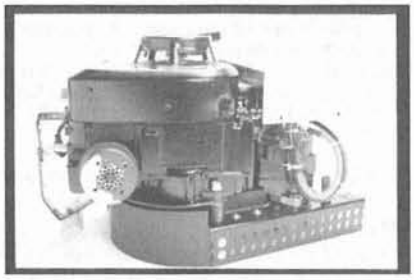


Figure 5—A rear view clearly shows the largest mechanical shield in place and the carry handle—made from L brackets—that protects the spark plug from damage.

JAMES ST. LAURENT

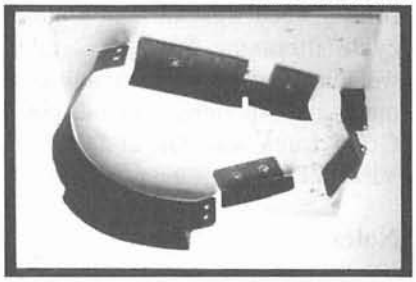


Figure 6—The protective shields, arranged on the plywood base to approximate their mounting positions.

Time to bend, bang, drill, flatten (bang some more), file and sand everything into its final shape. Polish all mechanical grounding points including the engine mounts. Cut the slot out of the back rail with a jigsaw. File off all sharp edges. When the relentless din of power tools, files, twisted blades and flying metal bits finally subsides, you will emerge victorious—and ready for subassembly and painting. Spray paint the mounts, rails and the control box with high-temperature engine enamel.

The protection circuit is built on a piece of perf board. When the output voltage exceeds 15.5 V, a heavy-duty, 5 V PC-board relay grounds the engine's magneto neutralizing wire to stop the engine.

The correct value for R2 depends on the relay's characteristics, so it must be set for each particular relay. To do so, install 10 kΩ pots in place of R1 and R2. Set both pots for maximum resistance. Connect an 18 V variable-voltage power supply across the circuit. (Connect the positive lead to D2's cathode and the negative lead to Q1's emitter.) Set the supply to your desired trigger voltage, and switch on the power. Adjust the R1 pot until the LED just lights. Then adjust the R2 pot until the relay just closes. The two adjustments may interact. Make a final adjustment of R1 when the Pup is complete with the control box installed and the battery disconnected. Finally, remove the pots, measure their values and replace them with combinations of fixed resistors.

Once my basic unit was tested, I added a pair of modified **L** brackets with a wood handle to the engine's right side. Together they span over the spark plug to protect it from being broken. (Do *not* loosen the cylinder head bolts to mount this!)

The protective mechanical shields that work well on my particular version are four custom-shaped pieces (cut from 22-gauge sheet metal stock, 7×24 inches). Machine screws hold them to the rails. (See Figures 5 and 6.) Attach the entire unit to a solid base (I used plywood) that blocks any access to the underside of the Pup. Editor Robert Schetgen, KU7G, suggests a lightweight hand cart as a base. Again, keep *all* the moving parts *completely* shielded!

You will love the 12 Volt Pup! It charges big batteries in a couple of hours. A gallon of gas lasts about four hours with a constant 20 A output. It usually loafs at low speed once a large battery has taken its initial charge. The gang at the Concordia University, VE2CUA, Field Day site was very interested in the Pup, and they first suggested that I write this article. Many members already have their own models churning in their minds. Richard Allix, VE2ARW, promises a miniature pup, to be born

from a weed whacker and a motorcycle alternator. You are certainly welcome to write me with your comments and experiences. Good Health, Good Luck and Great DX from VE2NYP!

Notes

[1]I did not locate a suitable automatic-reset circuit breaker. Manual-reset breakers in that current range (*eg*, Potter & Brumfield W31X2M1G-50) cost about $20, or more. A large fuse would be less expensive. Automobile manufacturers use a fusible link to protect the alternator output.—*Ed.*

[2]According to E. P. Rolek, K9SQG's "A Source for High-Current Relays," in Hints and Kinks (p 73) Wal Mart may be a good source for such parts.

Yaniko "Nick" Palis first became interested in radio communications in his early teens. After some 20 years of SWLing, he finally decided to get on the air by becoming VE2NYP in 1990. Nick ran his college's broadcast radio station and designed many high-power laser light shows in their heyday (up to the early 1980s). He was a lighting director for films and television specials and would sometimes design custom electronic special effects for movies. He was a unit and location manager for many years. Yaniko is presently a supervising producer for feature films and television series in international distribution. Amateur Radio has revived all those previous technical interests and put them to good use again! You can reach Nick by mail at PO Box 61 station Place du Parc, Montreal, PQ H2W 2M9, Canada.

Appendix A

ARRL Field Organization

The United States is divided into 15 ARRL Divisions. Every two years the ARRL full members in each of these divisions elect a director and a vice director to represent them on the League's Board of Directors. The Board determines the policies of the League, which are carried out by the Headquarters staff. A director's function is principally policymaking at the highest level, but the Board of Directors is all-powerful in the conduct of League affairs.

The 15 divisions are further broken down into 71 sections, and the ARRL full members in each section elect a Section Manager (SM). The SM is the senior elected ARRL official in the section, and in cooperation with the director, fosters and encourages all ARRL activities within the section. A breakdown of sections within each division (and counties within each splitstate section) follows:

ATLANTIC DIVISION: *Delaware, Eastern Pennsylvania*

(Adams, Berks, Bradford, Bucks, Carbon, Chester, Columbia, Cumberland, Dauphin, Delaware, Juniata, Lackawanna, Lancaster, Lebanon, Lehigh, Luzerne, Lycoming, Monroe, Montgomery, Montour, Northhampton, Northumberland, Perry, Philadelphia, Pike, Schuylkill, Snyder, Sullivan, Susquehanna, Tioga, Union, Wayne, Wyoming, York); *Northern New York* (Clinton, Essex, Franklin, Fulton, Hamilton, Jefferson, Lewis, Montgomery, Schoharie, St. Lawrence); *Maryland -D.C.*; *Southern New Jersey* (Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, Mercer, Ocean, Salem); *Western New York* (Allegany, Broome, Cattaraugus, Cayuga, Chautauqua, Chemung, Chenango, Cortland, Delaware, Erie, Genesee, Herkimer, Livingston, Madison, Monroe, Niagara, Oneida, Onondaga, Ontario, Orleans, Oswego, Otsego, Schuyler, Seneca, Steuben, Tioga, Tompkins, Wayne, Wyoming, Yates); *Western Pennsylvania* (those counties not listed under Eastern Pennsylvania).

CENTRAL DIVISION: *Illinois; Indiana; Wisconsin.*

DAKOTA DIVISION: *Minnesota; North Dakota; South Dakota.*

DELTA DIVISION: *Arkansas; Louisiana; Mississippi, Tennessee*

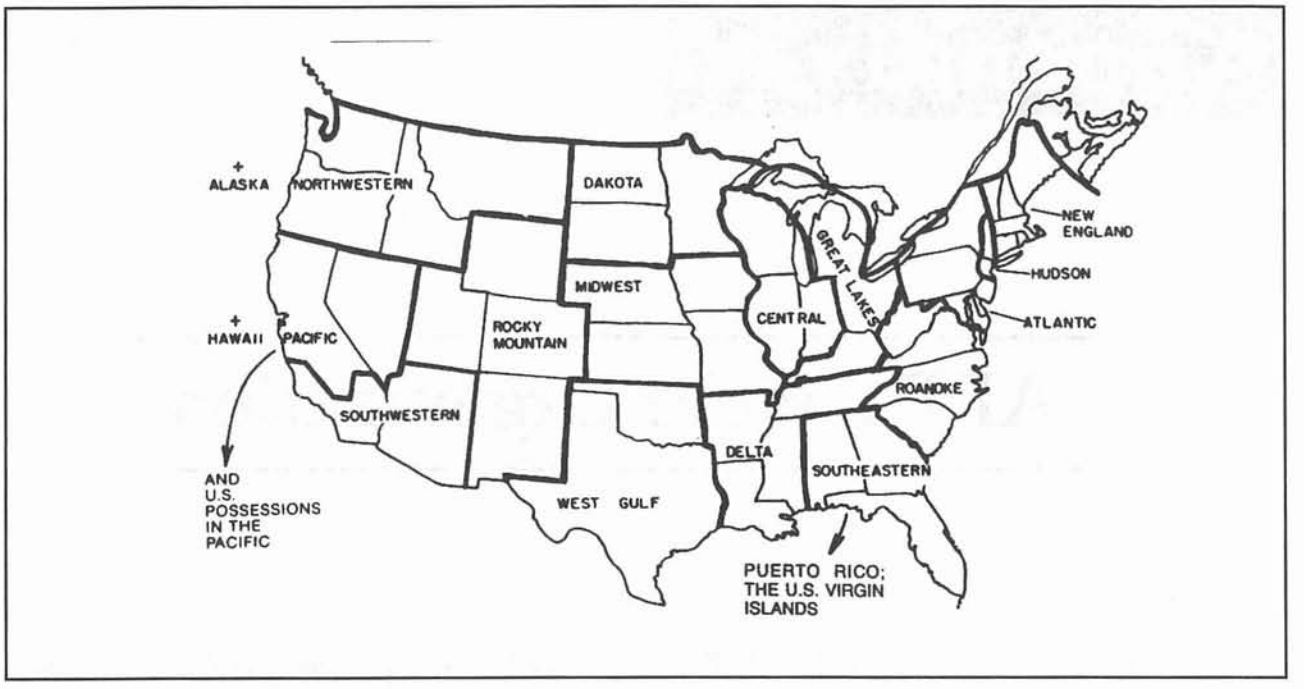
GREAT LAKES DIVISION; *Kentucky, Michigan; Ohio.*

HUDSON DIVISION: Eastern New York (Albany, Columbia, Dutchess, Greene, Orange, Putnam, Rensselaer, Rockland, Saratoga, Schenectady, Sullivan, Ulster, Warren, Washington, Westchester); *N.Y.C.-L.I.* (Bronx, Kings, Nassau, New York, Queens, Staten Island, Suffolk); *Northern New Jersey* (Bergen, Essex, Hudson, Hunterdon, Middlesex, Monmouth, Morris, Passaic, Somerset, Sussex, Union, Warren).

MIDWEST DIVISION: *Iowa; Kansas, Missouri, Nebraska.*

NEW ENGLAND DIVISION: *Connecticut, Maine, Eastern*

Massachusetts (Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth,



Suffolk); *New Hampshire; Rhode Island, Vermont, Western Massachusetts* (those counties not listed under Eastern Massachusetts).

NORTHWESTERN DIVISION: *Alaska; Idaho; Montana;*

Oregon; Eastern Washington (Adams, Asotin, Benton, Chelan, Columbia, Douglas, Ferry, Franklin, Garfield, Grant, Kittitas, Klickitat, Lincoln, Okangogan, Pend Oreille, Spokane, Stevens, Walla, Walla, Whitman, Yakima); *Western Washington* (Challam, Clark Cowlitz, Grays Harbor Island, Jefferson, King, Kitsap, Lewis, Mason, Pacific, Pierce, San Juan, Skagit, Skamania, Snohomish, Thurston, Wahkiakum, Whatcom).

PACIFIC DIVISION: *East Bay* (Alameda, Contra Costa, Napa, Solano); *Nevada; Pacific* (Hawaii and U.S. possessions in the Pacific); *Sacramento Valley* (Alpine, Amador, Butte, Colusa, El Dorado, Glenn, Lassen, Modoc, Nevada, Placer, Plumas, Sacramento, Shasta, Sierra, Siskiyou, Sutter, Tehama, Trinity, Yolo, Yuba); *San Francisco*, (Del Norte, Humboldt, Lake, Marin, Mendocino, San Francisco, Sonoma); *San Joaquin Valley* (Calaveras, Fresno, Kern, Kings, Madera, Mariposa, Merced, Mono, San Joaquin, Stanislaus, Tulare, Tuolumne); *Santa Clara Valley* (Monterey, San Benito, San Mateo, Santa Clara, Santa Cruz).

ROANOKE DIVISION: *North Carolina, South Carolina; Virginia; West Virginia.*

ROCKY MOUNTAIN DIVISION: *Colorado; Utah; New Mexico, Wyoming.*

SOUTHEASTERN DIVISION: *Alabama*; *Georgia; Northern Florida* (Alachua, Baker, Bay, Bradford, Calhoun, Citrus, Clay, Columbia, Dixie, Duval, Escambia, Flagler, Franklin, Gadsden, Gilchrist, Gulf, Hamilton, Hernando, Holmes, Jackson, Jefferson, Lafayette, Lake, Leon, Levy, Liberty, Madison, Marion, Nassau, Okaloosa, Orange, Pasco, Putnam, Santa Rosa, Seminole, St. Johns, Sumter, Suwanee, Taylor, Union, Volusia, Wakulla, Walton, Washington); *Southern Florida* (Brevard, Broward, Collier, Dade, Glades, Hendry, Indian River, Lee, Martin, Monroe, Okeechobee, Osceola, Palm Beach and St. Lucie); *Puerto Rico; U.S. Virgin Islands; West Central Florida* (Charlotte, DeSoto, Hardee, Highlands, Hillsborough, Manatee, Pinellas, Polk and Sarasota).

SOUTHWESTERN DIVISION: *Arizona; Los Angeles; Orange* (Inyo, Orange, Riverside, San Bernardino); *San Diego* (Imperial, San Diego); *Santa Barbara* (San Luis Obispo, Santa Barbara, Ventura).

WEST GULF DIVISION: *North Texas* (Anderson, Archer, Baylor, Bell, Bosque, Bowie, Brown, Camp, Cass, Cherokee, Clay, Collin, Comanche, Cooke, Coryell, Dallas, Delta, Denton, Eastland,

Ellis, Erath, Falls, Fannin, Franklin, Freestone, Grayson, Gregg, Hamilton, Harrison, Henderson, Hill, Hopkins, Hunt, Jack, Johnson, Kaufman, Lamar, Lampasas, Limestone, McLennan, Marion, Mills, Montague, Morris, Nacogdoches, Navarro, Palo Pinto, Panola, Parker, Rains, Red River, Rockwall, Rusk, Shelby, Smith, Somervell, Stephens, Tarrant, Throckmorton, Titus, Upshur, Van Zandt, Wichita, Wilbarger, Wise, Wood, Young); *Oklahoma; South Texas* (Angelina, Aransas, Atacosa, Austin, Bandera, Bastrop, Bee, Bexar, Blanco, Brazoria, Brazos, Brooks, Burleson, Burnet, Caldwell, Calhoun, Cameron, Chambers, Colorado, Comal, Concho, DeWitt, Dimmitt, Duval, Edwards, Fayette, Fort Bend, Frio, Galveston, Gillespie, Goliad, Gonzales, Grimes, Guadalupe, Hardin, Harris, Hays, Hidalgo, Houston, Jackson, Jasper, Jefferson, Jim Hogg, Jim Wells, Karnes, Kendall, Kenedy, Kerr, Kimble, Kinney, Kleberg, LaSalle, Lavaca, Lee, Leon, Liberty, Live Oak, Llano, Madison, Mason, Matagorda, Maverick, McCulloch, McMullen, Medina, Menard, Milam, Montgomery, Newton, Nueces, Orange, Polk, Real, Refugio, Robertson, Sabine, San Augustine, San Jacinto, San Patricio, San Saba, Starr, Travis, Trinity, Tyle, Uvalde, Val Verde, Victoria, Walker, Waller, Washington, Webb, Wharton, Willacy, Williamson, Wilson, Zapata, Zavala); *West Texas* (Andrews, Armstrong, Bailey, Bordon, Brewster, Briscoe, Callahan, Carson, Castro, Childress, Cochran, Coke, Coleman, Collingsworth, Cottle, Crane, Crockett, Crosby, Culberson, Dallam, Dawson, Deaf Smith, Dickens, Donley, Ector, El Paso, Fischer, Floyd, Foard, Gaines, Garza, Glasscock, Gray, Hale, Hall, Hansford, Hardeman, Hartley, Haskell, Hemphill, Hockley, Howard Hudspeth, Hutchinson, Irion, Jeff Davis, Jones, Kent, King, Knox, Lamb, Lipscomb, Loving, Lubbock, Lynn, Martin, Midland, Mitchell, Moore, Motley, Nolan, Ochiltree, Oldham, Parmer, Pecos, Potter, Presidio, Randall, Reagan, Reeves, Roberts, Runnels, Schleicher, Scurry, Shackelford, Sherman, Sterling, Stonewall, Sutton, Swisher, Taylor, Terrell, Terry, Tom Green, Upton, Ward, Wheeler, Winkler, Yoakum).

RAC RADIO AMATEURS OF CANADA-CANADA; *Alberta; British Columbia; Manitoba; Maritime* (Nova Scotia, New Brunswick, Prince Edward Island); *Newfoundland/Labrador*; *Ontario; Quebec; Saskatchewan.*

SECTION MANAGER

In each ARRL section there is an elected Section Manager (SM) who will have authority over the Field Organization in his or her section, and in cooperation with his Director, foster and encourage ARRL activities and programs within the section. Details regarding the election procedures for SMs are contained in "Rules and Regulations of the ARRL Field Organization," available on request to any ARRL member. Election notices are posted regularly in the Happenings section of *QST*.

Any candidate for the office of Section Manager must be a resident of the section, a licensed amateur of the Technician class or higher, and a full member of the League for a continuous term of at least two years immediately preceding receipt of a petition for nomination at Hq. If elected, he or she must maintain membership throughout the term of office.

The following is a detailed resume of the duties of the Section Manager. In discharging his responsibilities, he:

a) Recruits and appoints nine section-level assistants to serve under his general supervision and to administer the following ARRL programs in the section: emergency communications, message traffic, official observers, affiliated clubs, public information, state government liaison, technical activities and on-the-air bulletins.

b) Supervises the activities of these assistants to ensure continuing progress in accordance with overall ARRL policies and objectives.

c) Appoints qualified ARRL members in the section to volunteer positions of responsibility in support of section programs, or authorizes the respective section-level assistants to make such appointments.

d) Maintains liaison with the Division Director and makes periodic reports to him regarding the status of section activities; receives from him information and guidance pertaining to matters of mutual concern and interest; serves on the Division Cabinet and renders advice as requested by the Division Director; keeps informed on matters of policy that affect section-level programs.

e) Conducts correspondence or other communications, including personal visits to clubs, hamfests and conventions, with ARRL members and affiliated clubs in the section; either responds to their questions or concerns or refers them to the

appropriate person or office in the League organization; maintains liaison with, and provides support to, representative repeater frequency coordinating bodies having jurisdiction in the section.

f) Writes, or supervises preparation of, the monthly Section News column in *QST* to encourage member participation in the ARRL program in the section.

g) Recruits new amateurs and ARRL members to foster growth of Field organization programs and the amateur service's capabilities in support of public service.

[Note: Move of permanent residence outside the section from which elected will be grounds for declaring the office vacant.]

ARRL LEADERSHIP APPOINTMENTS

Field Organization leadership appointments from the Section Manager are available to qualified ARRL full members in each section. These appointments are as follows: Assistant Section Manager, Section Emergency Coordinator, Section Traffic Manager, Official Observer Coordinator, State Government Liaison, Technical Coordinator, Affiliated Club Coordinator, Public Information Officer, Bulletin Manager, District Emergency Coordinator, Emergency Coordinator and Net Manager. Holders of such appointments may wear the League emblem pin with the distinctive deep-green background. Functions of these leadership officials are described below.

Assistant Section Manager

The ASM is an ARRL section-level official appointed by the Section Manager, in addition to the Section Manager's eight section-level assistants. An ASM may be appointed if the Section Manager believes such an appointment is desirable to meet the goals of the ARRL Field Organization in that section. Thus, the ASM is appointed at the complete discretion of the Section Manager, and serves at the pleasure of the Section Manager.

1) The ASM may serve as a general or as a specialized assistant to the Section Manager. That is, the ASM may assist the Section Manager with general leadership matters as the Section Manager's general understudy, or the ASM may be assigned to handle a specific important function not within the scope of the duties of the Section Manager's eight assistants.

2) At the Section Manager's discretion, the ASM may be designated as the recommended successor to the incumbent Section Manager, in case the Section Manager resigns or is otherwise unable to finish the term of office.

3) The ASM should be familiar with "Guidelines for the ARRL Section Manager," which contains the fundamentals of general section management.

4) The ASM must be an ARRL full member, holding at least a Novice class license.

Section Emergency Coordinator

The SEC must hold a Technician class license or higher and is appointed by the Section Manager to take care of all matters pertaining to emergency communications and the Amateur Radio Emergency Service (ARES) on a sectionwide basis. The duties of the SEC include the following:

1) The encouragement of all groups of community amateurs to establish a local emergency organization.

2) Recommendations to the SM on all section emegency policy and planning, including the development of a section emergency communications plan.

3) Cooperation and Coordination with the Section Traffic Manager so that emergency nets and traffic nets in the section present a unified public sevice front. Cooperation and coordiantion should also be maintained with other section leadership officials as appropriate, particularly the State Governmnent Liaison and the Public Information Coordinator.

4) Recommendations of candidates for Emergency Coordinator and District Emergency Coordinator appointments (and cancellations) to the Section Manager and determinations of areas of jurisdiction of each amateur so appointed. At the SM's discretion, the SEC may be directly in charge of making (and cancelling) such appointments. In the same way, the SEC can handle the Official Emergency Station program.

5) Promotion of ARES membership drives, meetings, activities, tests, procedures, etc., at the section level.

6) Collection and consolidation of Emergency Coordinator (or District Emergency Coordinator) monthly reports and submission of monthly progress summaries to ARRL Hq.

7) Maintenance of contact with other communication services and liaison at the section level

with all agencies served in the public interest, particularly in connection with state and local government, civil preparedness, Red Cross, Salvation Army and the National Weather Service. Such contact is maintained in cooperation with the State Government Liaison.

Section Traffic Manager

The STM is appointed by the Section Manager to supervise traffic handling organization at the section level–that is, of coordinating the activities of all traffic nets, both National Traffic System-affiliated and independents, so that routings within the section and connections with other nets to effect orderly and efficient traffic flow are maintained. The STM should be a person at home and familiar with traffic handling on all modes, must have at least a Technician class license, and should possess the willingness and ability to devote equal consideration and time to all section traffic matters. The duties of the STM include the following:

1) Establish, administer, and promote a traffic handling program at the section level, based on, but not restricted to, National Traffic System networks.

2) Develop and implement one or more effective training programs within the section that addresses the needs of both traditional and digital modes of traffic handling. Ensure that Net Managers place particular emphasis on the needs of amateurs new to formal network traffic handling, as well as those who receive, send, and deliver formal traff ic on a "casual" basis, via RTTY, Amtor, and Packet based message storage and bulletin board systems.

3) Cooperate and coordinate with the Section Emergency Coordinator so that traffic nets and emergency nets in the section present a unified public service front.

4) Recommend candidates for Net Managers and Official Relay Station appointments to the SM. Issue FSD-211 appointment/cancellation cards and appropriate certificates. At the SM's discretion, the STM may directly make or cancel NM and ORS appointments.

5) Ensure that all traffic nets within the section are properly and adequately staffed, with appropriate direction to Net Managers, as required, which. results in coverage of all Net Control liaison functions. Assign liaison coverage adequate to ensure that all digital bulletin boards and message storage systems within the section are polled on a daily basis, to prevent misaddressed, lingering, or duplicated radiogram-formatted message traffic.

6) Maintain familiarity with proper traffic handling and directed net procedures applicable to all normally used modes within the section.

7) Collect and prepare accurate monthly net reports and submit them to ARRL Headquarters, either directly or via the Section Manager, but in any case on or prior to the established deadlines.

Affiliated Club Coordinator

The ACC is the primary contact and resource person for each Amateur Radio club in the section, specializing in providing assistance to clubs. The ACC is appointed by, and reports to, the Section Manager. Duties and qualifications of the ACC include:

1) Volunteer a great deal of time in getting to know the Amateur Radio clubs' members and officers person to person in his or her section. Learn their needs, strengths and interests and work with them to make clubs effective resources in their communities and more enjoyable for their members.

2) Encourage affiliated clubs in the section to become more active and, if the club is already healthy and effective, to apply as a Special Service Club (SSC).

3) Supply interested clubs with SSC application forms.

4) Assist clubs in completing SSC application forms, if requested.

5) Help clubs establish workable programs to use as SSCs.

6) Approve SSC application forms and pass them to the SM.

7) Work with other section leadership officials (Section Emergency Coordinator, Public Information Coordinator, Technical Coordinator, State Government Liason, etc.) to ensure that clubs are involved in the mainstream of ARRL Field Organization activities.

8) Encourage new clubs to become ARRL affiliated.

9) Ensure that annual progress reports (updated officers, liaison mailing addresses, etc.) are forthcoming from all affiliated clubs.

10) Novice Class license; ARRL membership required.

Bulletin Manager

Rapid dissemination of information is the lifeblood of an active, progressive organization. The ARRL Official Bulletin Station network provides a vital communications link for informing the amateur community of the latest developments in Amateur Radio and the ARRL. The ARRL Bulletin Manager is responsible for recruiting and supervising a team of Official Bulletin Stations to disseminate such news and information of interest to amateurs in the section and to provide a means of getting the news and information to all OBS appointees. The bulletins should include the content of ARRL bulletins (transmitted by W1AW), but should also include items of local, section and regional interest from other sources, such as ARRL section leadership officials, as well as information provided by the Division Director.

A special effort should be made to recruit an OBS for each major repeater and packet bulletin board in the section. This is where the greatest "audience" is to be found, many of whom are not sufficiently informed about the latest news of Amateur Radio and the League. Such bulletins should be transmitted regularly, perhaps in conjunction with a repeater net or on a repeater "bulletin board" (tone-accessed recorded announcements for repeater club members).

Although the primary mission of OBS appointees is to copy ARRL bulletins directly from W1AW, in some sections the Bullein Manager may take on the responsibility of retransmitting ARRL bulletins (as well as other information) for the benefit of OBS appointees, on a regularly scheduled day, time and frequency. An agreed-upon schedule should be worked out in advance. Time is of the essence when conveying news; therefore a successful Bulletin Manager will develop ways of communicating with the OBS appointees quickly and efficiently.

Bulletin Managers should be familiar with the position description of the Official Bulletin Station, which appears later. The duties of the Bulletin Manager include the following:

1) The Bulletin Manager must have a Technician class license or higher, and maintain League membership.

2) The Bulletin Manager is appointed by the SM and is required to report regularly to the SM concerning the section's bulletin program.

3) The Bulletin Manager is responsible for recruiting (and, at the discretion of the SM, appointing) and supervising a team of Official Bulletin Stations in the Section. A special effort should be made to recruit OBSs for each major repeater and PBBS in the section.

4) The Bulletin Manager must be capable of copying ARRL bulletins directly from W1AW on the mode(s) necessary. The Bulletin Manager may, in some cases, be required to retransmit ARRL bulletins for OBS appointees who might be unable to copy them directly from W1AW.

5) The Bulletin Manager is also responsible for funneling news and information of a local, section and regional nature to OBS appointees. In so doing, the Bulletin Manager must maintain close contact with other section-level officials, and the Division Director, to maintain an organized and unified information flow within the section.

Official Observer Coordinator

The Official Observer Coordinator is an ARRL section-level leadership official appointed by the Section Manager to supervise the Official Observer program in the section. The OO Coordinator must hold a General class (or higher amateur license and be licensed as a Technician or higher for at least four years.

The Official Observer program has operated for more than half a century, and in that time, OO appointees have assisted thousands of amateurs whose signals, or operating procedures, were not in compliance with the regulations. The function of the OO is to listen for amateurs who might otherwise come to the attention of the FCC and to advise them by mail of the irregularity observed. The OO program is, in essence, for the benefit of amateurs who want to be helped. Official Observers must meet high standards of expertise and experience. It is the job of the OO Coordinator to recruit, supervise and direct the efforts of OOs in the section, and to report their activity monthly to the Section Manager and to ARRL Hq.

The OO Coordinator is a key figure in the Amateur Auxiliary to the FCC's Field Operations Bureau, the foundation of which is an enhanced OO program. Jointly created by the FCC and ARRL in response to federal enabling legislation (Public Law 97-259), the Auxiliary permits a close relationship between FCC and ARRL Field Organization volunteers in monitoring the amateur airwaves

for potential rules discrepanciestviolations. (Contact your Section Manager for further details on the Amateur Auxiliary program.)

Public Information Coordinator

The ARRL Public Information Coordinator is a section-level official appointed by the Section Manager to be the section's expert on public information and public relations matters. The Public Information Coordinator is also responsible for organizing, guiding and coordinating the activities of the Public Information Officers within the section.

The Public Information Coordinator must be a full member of the ARRL and, preferably, have professional public relations or journalism experience or a significantly related background in dealing with the public media.

The purpose of public relations goes beyond column inches and minutes of air time. Those are means to an end–generally, telling a specific story about hams, ham radio or ham-related activities for a specific purpose. Goals may range from recruiting potential hams for a licensing course to improving public awareness of amateurs' service to the community. Likewise, success is measured not in column inches or air time, but in how well that story gets across and how effectively it generates the desired results.

For this reason, public relations are not conducted in a vacuum. Even the best PR is wasted without effective follow-up. To do this best, PR activities must be well-timed and wellcoordinated within the amateur community, so that clubs, Elmers, instructors and so on are prepared to deal with the interest the PR generates. Effective PICs will convey this goal-oriented perspective and aftitude to their PlOs and help them coordinate public relations efforts with others in their sections.

Recruitment of new hams and League members is an integral part of the job of every League appointee. Appointees should take advantage of every opportunity to recruit a new ham or a member to foster growth of Field Organization programs, and our abilities to serve the public.

Specific Duties of the Public Information Coordinator

1) Advises the Section Manager on building and maintaining a positive public image for Amateur Radio in the section; keeps the SM informed of all significant events which would benefit from the SM's personal involvement and reports regularly to the SM on activities.

2) Counsels the SM in dealing with the media and with government officials, particularly when representing the ARRL and/or Amateur Radio in a public forum.

3) Maintains contact with other section level League officials, particularly the Section Manager and others such as the State Government Liaison, Section Emergency Coordinator and Bulletin Manager on matters appropriate for their attention and to otherwise help to assure and promote a coordinated and cohesive ARRL Field Organization.

4) Works closely with the section Affiliated Club Coordinator and ARRL-affiliated clubs in the section to recruit and train a team of Public Information Officers (PIOs). With the approval of the Section Manager, makes PIO appointments within the section.

5) Works with the SM and other PICs in the division to:

a) develop regional training programs for PlOs and club publicity chairpersons;

b) coordinate public relations efforts for events and activities which may involve more than one section, and

c) provide input on matters before the League's Public Relations Committee for discussion or action.

6) Establishes and coordinates a section-wide Speakers Bureau to provide knowledgeable and effective speakers who are available to address community groups about Amateur Radio, and works with PlOs to promote interest among those groups.

7) Helps local PlOs to recognize and publicize newsworthy stories in their areas. Monitors news releases sent out by the PlOs for stories of broader interest and offers constructive comments for possible improvement. Helps local PlOs in learning to deal with, and attempting to minimize, any negative publicity about Amateur Radio or to correct negative stories incorrectly ascribed to Amateur Radio operators.

8) Working with the PlOs, develops and maintains a comprehensive list of media outlets and contacts in the section for use in section-wide or nationwide mailings.

9) Helps local PlOs prepare emergency response PR kits containing general information on Ama-

teur Radio and on local clubs, which may be distributed in advance to local Emergency Coordinators and District Emergency Coordinators for use in dealing with the media during emergencies.

10) Works with PIOs, SM and ARRL staff to identify and publicize League-related stories of local or regional interest, including election or appointment of ARRL leadership officials, scholarship winners/award winners, *QST* articles by local authors or local achievements noted or featured in *QST*.

11) Familiarize self with ARRL Public Service Announcements (PSAs), brochures and audio-visual materials; assists PIOs in arranging air time for PSAs; helps PIOs and speakers choose and secure appropriate brochures and audio-visual materials for events or presentations.

12) At the request of the Section Manager or Division Director, may assist in preparation of a section or division newsletter.

13) Encourages, organizes and conducts public information/public relations sessions at ARRL hamfests and conventions.

14) Works with PIOs to encourage activities that place Amateur Radio in the public eye, including demonstrations, Field Day activities, etc. and assures that sponsoring organizations are prepared to follow up on interest generated by these activities.

Most public relations activities are conducted on a local level by affiliated clubs, which generally are established community organizations. PICs should encourage clubs to make public relations a permanent part of their activities.

With the Section Manager's approval, the PIC may appoint club publicity chairpersons or other individuals recommended by affiliated clubs as PIOs. Where the responsibility cannot or will not be assumed by the club, the PIC is encouraged to seek qualified League members who are willing to accept the responsibility of PIO appointments.

Appointees should take advantage of every opportunity to recruit a new ham or member to foster growth of Field Organization programs, and our abilities to serve the public.

State Government Liaison

The State Government Liaison (SGL) shall be an amateur who is aware (at a minimum) of state legislative proposals in the normal course of events and who can watch for those proposals having the potential to affect Amateur Radio without creating a conflict of interest.

The SGL shall collect and promulgate information on state ordinances affecting Amateur Radio and work (with the assistance of other ARRL members) toward assuring that they work to the mutual benefit of society and the Amateur Radio Service.

The SGL shall guide, encourage and support ARRL members in representing the interests of the Amateur Radio Service at all levels. Accordingly, the SGL shall cooperate closely with other section-level League officials, particularly the Section Emergency Coordinator and the Public Information Coordinator.

When monitoring state legislative dockets, SGL's should watch for key words that could lead to potential items affecting Amateur Radio. Antennas (dish, microwave, towers, structures, satellite, television, lighting), mobile radio, radio receivers, radio interference, television interference, scanners, license plates, cable television, ham radio, headphones in automobiles, lightning protection, antenna radiation and biological effects of radio signals are a few of the examples of what to look for.

In those states where there is more than one section, the Section Managers whose territory does not encompass the state capital may simply defer to the SGL appointed by their counterpart in the section where the state capital is located. In this case, the SGL is expected to communicate equally with all Section Managqrs (and Section Emergency Coordinators and other section-level League officials). In sections where there is more than one government entity, i.e., Maryland, DC, Pacific, there may be a Liaison appointed for each entity.

Technical Coordinator

The ARRL Technical Coordinator (TC) is a section-level official appointed by the Section Manager to coordinate all technical activities within the section. The Technical Coordinator must hold a Novice class or higher amateur license. The Technical Coordinator reports to the Section Manager and is expected to maintain contact with other section-level appointees as appropriate to ensure a unified ARRL Field Organization within the section. The duties of the Technical Coordinator are as follows:

1) Supervise and coordinate the work of the section's Technical Specialists (TSs).

2) Encourage amateurs in the section to share their technical achievements with others through the pages of *QST*, and at club meetings, hamfests and conventions.

3) Promote technical advances and experimentation at VHF/UHF and with specialized modes, and work closely with enthusiasts in these fields within the section.

4) Serve as an advisor to radio clubs that sponsor training programs for obtaining amateur licenses or upgraded licenses in cooperation with the ARRL Affiliated Club Coordinator.

5) In times of emergency or disaster, function as the coordinator for establishing an array of equipment for communications use and be available to supply technical expertise to government and relief agencies to set up emergency communication networks, in cooperation with the ARRL Section Emergency Coordinator.

6) Refer amateurs in the section who need technical advice to local TSs.

7) Encourage TSs to serve on RFI and TVI committees in the section for the purpose of rendering technical assistance as needed, in cooperation with the ARRL OO Coordinator.

8) Be available to assist local technical program committees in arranging suitable programs for ARRL hamfests and conventions.

9) Convey the views of section amateurs and TSs about the technical contents of *QST* and ARRL books to ARRL HQ. Suggestions for improvements should also be called to the attention of the ARRL HQ technical staff.

10) Work with the appointed ARRL TAs (technical advisors) when called upon.

11) Be available to give technical talks at club meetings, hamfests and conventions in the section.

District Emergency Coordinator

The DEC is an ARRL full member of at least Technician class experienced in emergency communications who can assist the SEC by taking charge in the area of jurisdiction especially during an emergency. The DEC shall:

1) Coordinate the training, organization and emergency partication of Emergency Coordinators in the area of jurisdiction.

2) Make local decisions in the absence of the SEC or through coordination with the SEC concerning the allotment of available amateurs and equipment during an emergency.

3) Coordinate the interrelationship between local emergency plans and between communications networks within the area of jurisdiction.

4) Act as backup for local areas without an Emergency Coorinator and assist in maintaining contact with governmental and other agencies in the area of jurisdiction.

5) Provide direction in the routing and handling of emergency communications of either a fiormal or tactical nature.

6) Recommend EC appointments to the SEC and advise on OES appointments.

7) Coordinate the reporting and documentation of ARES activities in the area of jurisdiction.

8) Act as a model emergency communicator as evidenced by dedication to purpose, reliability and understanding of emergency communications.

9) Be fully conversant in National Traffic System routing and procedures as well as have a thorough understanding of the locale and role of all vital governmental and volunteer agencies that could be involved in an emergency.

EMERGENCY COORDINATOR

The ARRL Emergency Coordinator is a key team player in ARES on the local emergency scene. Working with the Section Emergency Coordinator, the DEC and Official Emergency Stations, the EC prepares for, and engages in management of communications needs in disasters. EC duties include:

1) Promote and enhance the activities of the Amateur Radio Emergency Service (ARES) for the benefit of the public as a voluntary, non-commercial communications service.

2) Manage and coordinate the training, organization and emergency participation of interested amateurs working in support of the communities, agencies orfunctions designated bythe Section Emergency Coordinator/Section Manager.

3) Establish viable working relationships with federal, state, county, city governmental and private agencies in the ARES jurisdictional area which need the services of ARES in emergencies. Determine what agencies are active in your area, evaluate each of their needs, and which ones you are capable of meeting, and then prioritize these agencies and needs. Discuss your planning with your Section Emergency Coordinator and then with your counterparts in each of the agencies. Ensure they are all aware of your ARES group's capabilities,

and perhaps more importantly, your limitations.

4) Develop detailed local operational plans with "served" agency officials in your jurisdiction that set forth precisely what each of your expectations are during a disaster operation. Work jointly to establish protocols for mutual trust and respect. All matters involving recruitment and utilization of ARES volunteers are directed by you, in response to the needs assessed by the agency officials. Technical issues involving message format, security of message transmission, Disaster Welfare Inquiry policies, and others, should be reviewed and expounded upon in your detailed local operations plans.

5) Establish local communications networks run on a regular basis and periodically test those networks by conducting realistic drills.

6) Establish an emergency traffic plan, with Welfare Traffic inclusive, utilizing the National Traffic System as one active component for traffic handling. Establish an operational liaison with local and section nets, particularly for handling Welfare traffic in an emergency situation.

7) In times of disaster, evaluate the communications needs of the jurisdiction and respond quickly to those needs. The EC will assume authority and responsibility for emergency response and performance by ARES personnel under his jurisdiction.

8) Work with other non-ARES amateur provider-groups to establish mutual respect and understanding, and a coordination mechanism for the good of the public and Amateur Radio. The goal is to foster an efficient and effective Amateur Radio response overall.

9) Work for growth in your ARES program, making it a stronger, more valuable resource and hence able to meet more of the agencies' local needs. There are thousands of new Technicians coming into the amateur service that would make ideal additions to your ARES roster. A stronger ARES means a better ability to serve your communities in times of need and a greater sense of pride for Amateur Radio by both amateurs and the public.

10) Report regularly to the SEC, as required.

Recruitment of new hams and League members is an integral part of the job of every League appointee. Appointees should take advantage of every opportunity to recruit a new ham or member to foster growth of Field Organization programs, and our abilities to serve the public.

Net Manager

For coordinating and supervising traffic-handling activities in the section, the SM may appoint one or more Net Managers, usually on recommendation of the Section Traffic Manager. The number of NMs appointed may depend on a section's geographical size, the number of nets operating in the section, or other factors having to do with the way the section is organized. In some cases, there may be only one Net Manager in charge of the one section net, or one NM for the phone net, one for the CW net. In larger or more traffic-active sections there may be several, including NMS for the VHF net or nets, for the RTTY net, or NTS local nets not controlled by ECs. All ARRL NMs should work under the STM in a coordinated section traffic plan.

Some nets cover more than one section but operate in NTS at the section level. In this case, the Net Manager is selected by agreement among the STMs concerned and the NM appointment conferred on him by his resident SM.

NMs may conduct any testing of candidates for ORS appointment (see below) that they consider necessary before making appointment recommendations to the STM. Net Managers also have the function of requiring that all traffic handling in ARRL recognized nets is conducted in proper ARRL form.

Remember: All appointees or appointee candidates must be ARRL full members.

ARRL STATION APPOINTMENTS

Field Organization station and individual appointments from the Section Manager are available to qualified ARRL full members in each section. These appointments are as follows: Official Relay Station, Official Emergency Station, Official Bulletin Station, Public Information Officer, Official Observer and Technical Specialist. All appointees receive handsome certificates from the SM and are entitled to wear ARRL membership pins with the distinctive blue background. All appointees are required to submit regular reports to maintain appointments and to remain active in their area of specialty.

The report is the criterion of activity. An appointee who misses three consecutive monthly reports is subject to cancellation by the SM of the appropriate section leadership official, who cannot know what or how much you are doing unless

you report. An appointee whose appointment is cancelled for this or other reasons must earn reinstatement by demonstrating activity and adherence to the requirements. Reinstatement of cancelled appointments, and indeed judgment of whether or not a candidate meets the requirements, is at the discretion of the SM and the section leadership.

The detailed qualifications of the six individual "station" appointments are given below. If you are interested, your SM will be glad to receive your application. Use application form FSD-187, reproduced nearby.

Official Relay Station

This is a traffic-handling appointment that is open to all licenses. This appointment applies equally to all modes and all parts of the spectrum. It is for traffic handlers, regardless of how or in what part of the spectrum they do it.

The potential value of the operator who has traffic know-how to his country and community is enhanced by his ability and the readiness of his station to function in the community interest in case of emergency. Traffic awareness and experience are often the signs by which mature amateurs may be distinguished.

Traditionally, there have been considerable differences between procedures for traffic handling by CW, phone, RTTY, ASCII and other modes. Appointment requirements for ORS do not deal with these, but with factors equally applicable to all modes. The appointed ORS may confine activities to one mode or one part of the spectrum if he wishes although versatility does indeed make it possible to perform a more complete public service. The expectation is that the ORS will set the example in traffic handling, however it is done. To the degree that he is deficient in performing traffic functions by any mode, to that extent he does not meet the qualifications for the appointment. Here are the basic requirements:

1) Full ARRL membership and Novice class license or higher.

2) Code and/or voice transmission.

3) Transmission quality, by whatever mode, must be of the highest quality, both technically and operationally. For example, CW signals must be pure, chirpless and clickless, and code sending must be well spaced and properly formed. Voice transmission must be of proper modulation percentage or deviation, precisely enunciated with minimum distortion. RTTY must be clickless, proper shift, etc.

4) All ORSs are expected to follow standard ARRL operating practices (message form, ending signals, abbreviations or prowords, courtesy, etc.).

5) Regular participation in traffic activities, either freelance or ARRL-sponsored. The latter is encouraged, but not required.

6) Handle all record communications speedily and reliably and set the example in efficient operating procedures. All traffic is relayed or delivered promptly after receipt.

7) Report monthly to the STM, including a breakdown of traffic handled during the past calendar month.

Official Emergency Station

Amateur operators may be appointed as an Official Emergency Station (OES) by their Section Emergency Coordinator (SEC) or Section Manager (SM) at the recommendation of the EC, or DEC (if no EC) holding jurisdiction. The OES appointee must be an ARRL member and set high standards of emergency preparedness and operating. The OES appointee makes a deeper commitment to the ARES program in terms of functionality than does the rank-and-file ARES registrant.

The requirements and qualifications for the position include the following: Full ARRL membership; experience as an ARES registrant; regular participation in the local ARES organization including drills and tests; participation in emergency nets and actual emergency situations; regular reporting of activities.

The OES appointee is appointed to carry out specific functions and assignments designated by the appropriate EC or DEC. The OES appointee and the presiding EC or DEC, at the time of the OES appointment, will mutually develop a detailed, operational function/assignment and commitment for the new appointee. Together, they will develop a responsibility plan for the individual OES appointee that makes the best use of the individual's skills and abilities. During drills and actual emergency situations, the OES appointee will be expected to implement his/her function with professionalism and minimal supervision.

Functions assigned may include, but are not limited to, the following four major areas of responsibility:

OPERATIONS—Responsible for specific, pre-

determined operational asignments during drills or actual emergency situations. Examples include: Net Control Station or Net Liaison for a specific ARES net; Manage operation of a specified ARES VHF or HF digital BBS or MBO, or point-to-point link; Operate station at a specified emergency management office, Red Cross shelter or other served agency operations point.

ADMINISTRATION—Responsible for specific, pre-determined administrative tasks as assigned in the initial appointment commitment by the presiding ARES official. Examples include: Recruitment of ARES members; liaison with Public Information Officer to coordinate public information for the media; ARES registration data base management; victim/refugee data base management; equipment inventory; training; reporting; and postevent analysis.

LIAISON—Responsible for specific, pre-determined liaison responsibilities as assigned by the presiding EC or DEC. Examples include: Maintaining contact with assigned served agencies; Maintaining liaison with specified NTS nets; Maintaining liaison with ARES officials in adjacent jurisdictions; Liaison with mutual assistance or "jump" teams.

LOGISTICS—Responsible for specific, predetermined logistical functions as assigned. Examples include: transportation; Supplies management and procurement (food, fuel, water, etc.); Equipment maintenance and procurement-radios, computers, generators, batteries, antennas.

MANAGEMENT ASSISTANT—Responsible for serving as an assistant manager to the EC, DEC or SEC based on specific functional assignments or geographic areas of jurisdiction.

CONSULTING—Responsible for consulting to ARES officials in specific area of expertise.

OES appointees may be assigned to pre-disaster, post-disaster, and recovery functions. These functions must be specified in the OES's appointment commitment plan.

The OES appointee is expected to participate in planning meetings, and post-event evaluations. Following each drill or actual event, the EC/DEC and the OES appointee should review and update the OES assignment as required. The OES appointee must keep a detailed log of events during drills and actual events in his/her sphere of responsibility to facilitate this review.

Continuation of the appointment is at the discretion of the appointing official, based upon the OES appointee's fulfillment of the tasks he/she has agreed to perform.

Recruitment of new hams and League members is an integral part of the job of every League appointee. Appointees should take advantage of every opportunity to recruit a new ham or member to foster growth of Field Organization programs, and our abilities to serve the public.

Official Bulletin Station

Rapid dissemination of information is the lifeblood of an active, progressive organization. The ARRL Official Bulletin Station network provides a vital communications link for informing the amateur community of the latest developments in Amateur Radio and the League. ARRL bulletins, containing up-to-the minute news and information of Amateur Radio, are issued by League Hq as soon as such news breaks. These bulletins are transmitted on a regular schedule by ARRL Hq station W1AW.

The primary mission of OBS appointees is to copy these bulletins directly off the air from W1AW—on voice, CW or RTTY/ASCII—and retransmit them locally for the benefit of amateurs in the particular coverage area, many of whom may not be equipped to receive bulletins directly from W1AW.

ARRL bulletins of major importance or of wide-ranging scope are mailed from Hq to each Bulletin Manager and OBS appoin tee. However, some bulletins, such as the ARRL DX Bulletin (transmitted on Fridays UTC), are disseminated only by W1AW because of time value. Thus, it is advantageous for each OBS to copy W1AW directly. In some sections, the Bulletin Manager may assume the responsibility of copying the bulletins from W1AW; therefore, individual OBSs should be sure to meet the Bulletin Manager on a regular, agreed-upon schedule to receive the latest bulletins.

Inasmuch as W1AW operates on all bands (160-2 meters), the need for OBSs on HF has lessened somewhat in recent times. However, OBS appointments for HF operation can be conferred by the Section Manager (or the Bulletin Manager, depending on how the SM organizes the section) if the need is apparent. More important, to serve the greatest possible "audience," OBS appointees who can send ARRL bulletins over VHF repeaters are of maximum usefulness and are much in demand. If possible, an OBS who can copy bulletins directly

from W1AW (or the Bulletin Manager) should be assigned to each major repeater in the section. Bulletins should be transmitted regularly, perhaps in conjunction with a VHF repeater net, on a repeater bulletin board (toneaccessed recorded announcements for repeater club members), or via a local RTTY (computer) mailbox. Duties and requirements of the OBS include the following:

1) OBS candidates must have Novice class license or higher.

2) Retransmission of ARRL bulletins must be made at least once per week to maintain appointment.

3) OBS candidates are appointed by the Section Manager (or by the Bulletin Manager, if the SM so desires) and must adhere to a schedule that is mutually agreeable, as indicated on appointment application form FSD-187.

4) OBS appointees should send a monthly activity report (such as FSD-210, under "Schedules and Net Affiliations") to the Bulletin Manager, indicating bulletin transmissions made and generally updating the Bulletin Manager to any OBS-related activities. This reporting arrangement may be modified by the Bulletin Manager as he/she sees fit.

5) As directed by the Bulletin Manager, OBSs will include in their bulletin transmissions news of local, section and regional interest.

Public Information Officer

Public Information Officers (PIOs) are appointed by and report to the ARRL section Public Information Coordinator (PIC) generally upon the recommendation of an affiliated club and with the approval of the Section Manager (SM). PIOs are usually club publicity chairpersons and must be full ARRL members. Training for PIOs should be provided regularly on a sectional or regional basis by the PIC and/or other qualified people.

Good "grass roots" public relations activities involve regular and frequent publicizing of amateur activities through local news media plus community activities; school programs; presentations to service clubs and community organizations; exhibits and demonstrations; and other efforts which create a positive public image for Amateur Radio.

Public relations are not conducted in a vacuum. Even the best PR is wasted without effective follow-up. To do this best, PR activities must be well-timed and well-coordinated within the amateur community, so that clubs, Elmers, instructors and so on are prepared to deal with the interest the PR generates.

Recruitment of new hams and League members is an integral part of the job of every League appointee. Appointees should take advantage of every opportunity to recruit a new ham or member to foster growth of Field Organization programs, and our abilities to serve the public.

Specific Duties of the Public Information Officer

1) Establishes and maintains a list of media contacts in the local area; strives to establish and maintain personal contacts with appropriate representatives of those media (editors, news directors, science reporters and so on).

2) Becomes a contact for the local media and assures that editors/reporters who need information about Amateur Radio know where to find it.

3) Works with Local Government Liaisons to establish personal contacts with local government officials where possible and explain to them, briefly and non-technically, about Amateur Radio and how it can help their communities.

4) Keeps informed of activities by local hams and identifies and publicizes those that are newsworthy or carry human interest appeal. (This is usually done through news releases or suggestions for interviews or feature stories.)

5) Attempts to deal with and minimize any negative publicity about Amateur Radio and to correct any negative stories which are incorrectly ascribed to Amateur Radio operators.

6) Generates advance publicity through the local media of scheduled activities of interest to the general public, including licensing classes, hamfests, club meetings, Field Day operations, etc.

7) Works with the section PIC to identify and publicize Leaguerelated stories of local news interest, including election and appointment of hams to leadership positions, *QST* articles by local authors or local achievements noted or featured in *QST*.

8) Maintains contact with other League officials in the local area, particularly the Emergency Coordinator and/or District Emergency Coordinator. With the PIC, helps prepare an emergency response PR kit, including general brochures on Amateur Radio and specific information about local clubs. Distributes them to ECs and DECs before an emergency occurs. During emergencies, these kits should be made available to reporters at the scene or at a command post. The PIO should

help summarize Amateur Radio activity in an ongoing situation, and follow up any significant emergency communications activities with prompt reporting to media of the extent and nature of Amateur Radio involvement.

9) Assists the section PIC in recruiting hams for the section's Speakers Bureau; promotes interest among community and service organizations in finding out more about Amateur Radio through the bureau and relays requests to the PIC.

10) Helps individual hams and radio clubs to develop and promote good ideas for community projects and special events to display Amateur Radio to the public in a positive light.

11) Attends regional training sessions sponsored by section PICS.

12) Becomes familiar with ARRL Public Service Announcements (PSAs), brochures and audio-visual materials; contacts local radio and TV stations to arrange airing of Amateur Radio PSAs; secures appropriate brochures and audio-visual materials for use in conjunction with planned activities.

13) Keeps the section PIC fully informed on activities and places PIC on news release mailing list.

Official Observer

The Official Observer (OO) program has been sponsored by the League for over 50 years to help amateurs help each other. Official observer appointees have aided thousands of amateurs to maintain their transmitting equipment and operating procedures in compliance with the regulations. The object of the OO program is to notify amateurs by mail of operating/technical irregularities before they come to the attention of the FCC.

The ARRL commitment to volunteer monitoring has been greatly enhanced by the creation of the Amateur Auxiliary to the FCC Field Operations Bureau, designed to enable amateurs to play a more active and direct role in upholding the traditional high standard of conduct on the amateur bands. The OO is the foundation of the Amateur Auxiliary, carrying out the all-important day-to-day maintenance monitoring of the amateur airwaves. Following recommendation by the Section Manager, potential members of the Amateur Auxiliary are provided with training materials, and all applicants must successfully complete a written examination to be enrolled as Official Observers. For further information, please contact your SM.

The OO performs his function by listening rather than transmitting, keeping a watchful ear out for such things as frequency instability, harmonics, hum, key clicks, broad signals, distorted audio, overdeviation, out-of-band operation, etc. The OO completes his task once the notification card is sent. Reimbursement for postage expenses are provided for through the SM. The OO:

1) Must be an ARRL full member and have been a licensee of Technician class or higher for at least four years.

2) Must undergo and complete successfully the Amateur Auxiliary training and certification procedure.

3) Must report to the OO Coordinator regularly on FSD-23.

4) Maintain regular activity in sending out notices as observed.

The OO program is one of the most important functions of the League. A sincere dedication to helping our brother and sister amateurs is required for appointment. Only the "very best" are sought.

Technical Specialist

Appointed by the SM, or TC under delegated authority from the SM, the TS supports the TC in two main areas of responsibility: Radio Frequency Interference, and Technical Information. The TS must hold full ARRL membership and at least a Novice class license. TSs can specialize in certain specific technical areas, or can be generalists. Here is a list of specific job duties:

1) Serve as a technical oracle to local hams and clubs. Correspond by telephone and letter on tech topics. Refer correspondents to other sources if specific topic is outside TS's knowledge.

2) Serve as advisor in radio frequency interference issues. RFI can drive a wedge in neighbor and city relations. It will be the TS with a cool head who will resolve problems. Local hams will come to you for guidance in dealing with interference problems.

3) Speak at local clubs on popular tech topics. Let local clubs know you're available and willing.

4) Represent ARRL at technical symposiums in industry; serve on CATV advisory committees; advise municipal governments on technical matters.

5) Work with other ARRL officials and appointees when called upon for technical advice especially in emergency communications situations where technical prowess can mean the difference in getting a communications system up and run-

ning, the difference between life and death.

6) Handle other miscellaneous technically related tasks assigned by the Technical Coordinator.

Local Government Liaison

The Local Government Liaison (LGL) is primarily responsible for monitoring proposals and actions by local government bodiesand officials which may affect Amateur Radio; for working with the local PIO to alert section leadership officials and area amateurs to any such proposals or actions, and for coordinating local responses. In addition, the LGL serves as a primary contact for amateurs encountering problems dealing with local government agencies, for those who want to avoid problems and for local officials who wish to work with amateurs or simply learn more about Amateur Radio. The most effective LGL will be able to monitor local government dockets consistently, muster local, organized support quickly when necessary, and be well known in the local amateur community as the point person for local government problems. The LGL must be a Full Member of the ARRL. LGLs are appointed by and report to the Section Manager, or State Government Liaison (acting under delegated authority from the SM).

Specific Responsibilities:

1) Monitor proposals and actions of town/city councils zoning appeals boards, and any other legislative or regulatory agencies or officials below the state level whose actions can directly or indirectly affect Amateur Radio.

2) Attend meetings of those bodies when possible, to become familiar with their policies, procedures and members. Assist local amateurs in their dealings with local boards and agencies.

3) Be available to educate elected and appointed officials, formally and informally, about the value of Amateur Radio to their community.

4) Work with the PIO or PIC to inform local amateurs, the SGL and the SM of any proposals of actions which may affect Amateur Radio, and report regularly on the progress or lack thereof.

5) Work with the PIO to organize the necessary local response to any significant proposals or actions, either negative or positive, and coordinate that response.

6) Refer amateurs seeking ARRL Volunteer Counsels to HQ.

7) Register on mailing list for Planning Commission meeting agendas.

8) Work with the PIO and local clubs to build and/or maintain good relations between Amateur Radio and local officials. (For example, invite the mayor to a club dinner or council members to Field Day.)

Appendix B

ARRL Numbered Radiograms

The letters ARL are inserted in the preamble in the check and in the text before spelled out numbers, which represent texts from this list. Note that some ARL texts include insertion of numerals. *Example*: NR 1 R W1AW ARL 5 NEWINGTON CONN DEC 25 DONALD R SMITH AA 164 EAST SIXTH AVE AA NORTH RIVER CITY MO AA PHONE 733 3968 BT ARL FIFTY ARL SIXTY ONE BT DIANA AR. For additional information about traffic handling, see Chapter 7.

Group One—For Possible "Relief Emergency" Use

ONE	Everyone safe here. Please don't worry.
TWO	Coming home as soon as possible.
THREE	Am in _____ hospital. Receiving excellent care and recovering fine.
FOUR	Only slight property damage here. Do not be concerned about disaster reports.
FIVE	Am moving to new location. Send no further mail or communication. Will inform you of new address when relocated.
SIX	Will contact you as soon as possible.
SEVEN	Please reply by Amateur Radio through the amateur delivering this message. This is a free public service.
EIGHT	Need additional _____ mobile or portable equipment for immediate emergency use.
NINE	Additional _____ radio operators needed to assist with emergency at this location.
TEN	Please contact _____. Advise to standby and provide further emergency information, instructions or assistance.
ELEVEN	Establish Amateur Radio emergency communications with _____ on _____ MHz.
TWELVE	Anxious to hear from you. No word in some time. Please contact me as soon as possible.
THIRTEEN	Medical emergency situation exists here.
FOURTEEN	Situation here becoming critical. Losses and damage from _____ increasing.
FIFTEEN	Please advise your condition and what help is needed.
SIXTEEN	Property damage very severe in this area.
SEVENTEEN	REACT communications services also available. Establish REACT communications with _____ on channel _____.
EIGHTEEN	Please contact me as soon as possible at _____.
NINETEEN	Request health and welfare report on _____. (State name, address and telephone number.)
TWENTY	Temporarily stranded. Will need some assistance. Please contact me at _____.
TWENTY ONE	Search and Rescue assistance is needed by local authorities here. Advise availability.
TWENTY TWO	Need accurate information on the extent and type of conditions now existing at your location. Please furnish this information and reply without delay.
TWENTY THREE	Report at once the accessibility and best way to reach your location.
TWENTY FOUR	Evacuation of residents from this area urgently needed. Advise plans for help.
TWENTY FIVE	Furnish as soon as possible the weather conditions at your location.
TWENTY SIX	Help and care for evacuation of sick and injured from this location needed at once.

Emergency/priority messages originating from official sources must carry the signature of the originating official.

Group Two—Routine messages

FORTY SIX	Greetings on your birthday and best wishes for many more to come.
FIFTY	Greetings by Amateur Radio.
FIFTY ONE	Greetings by Amateur Radio. This message is sent as a free public service by ham radio operators here at _____. Am having a wonderful time.
FIFTY TWO	Really enjoyed being with you. Looking forward to getting together again.
FIFTY THREE	Received your _____. It's appreciated; many thanks.
FIFTY FOUR	Many thanks for your good wishes.
FIFTY FIVE	Good news is always welcome. Very delighted to hear about yours.
FIFTY SIX	Congratulations on your _____, a most worthy and deserved achievement.
FIFTY SEVEN	Wish we could be together.
FIFTY EIGHT	Have a wonderful time. Let us know when you return.
FIFTY NINE	Congratulations on the new arrival. Hope mother and child are well.
*SIXTY	Wishing you the best of everything on _____.
SIXTY ONE	Wishing you a very merry Christmas and a happy New Year.
*SIXTY TWO	Greetings and best wishes to you for a pleasant _____ holiday season.
SIXTY THREE	Victory or defeat, our best wishes are with you. Hope you win.
SIXTY FOUR	Arrived safely at _____.
SIXTY FIVE	Arriving _____ on _____. Please arrange to meet me there.
SIXTY SIX	DX QSLs are on hand for you at the _____ QSL Bureau. Send _____ self-addressed envelopes.
SIXTY SEVEN	Your message number _____ undeliverable because of _____. Please advise.
SIXTY EIGHT	Sorry to hear you are ill. Best wishes for a speedy recovery.
SIXTY NINE	Welcome to the _____. We are glad to have you with us and hope you will enjoy the fun and fellowship of the organization.

* Can be used for all holidays.

Note: ARL numbers should be spelled out at all times.

Appendix C

Training

Amateur Radio operators need training in operating procedures and communication skills. In an emergency, radios don't communicate, but people do. Because radio amateurs with all sorts of varied interests participate, many of those who offer to help may not have experience in public service activities.

Proper disaster training replaces chaotic pleas with smooth, organized communications. Well-trained communicators respond during drills or actual emergencies with quick, effective and efficient communications. The ARRL recognizes the need for emergency preparedness and emergency communications training through sponsorship of the ARES and the Amateur Radio Emergency Communications Course that is a part of the ARRL Certifications and Continuing Education Program.

If you want to take a course to learn about computers, crafts, gourmet cooking, baking, gardening, small engine repair, or any other hobby, you usually only have to look as far as the nearest school or community college. Such courses are offered in a variety of settings — evening school, day school, or on-line.

But where does a ham go to learn more about his or her hobby? Many clubs offer licensing classes, but courses in other areas of ham radio are fairly rare. Once in a while seminars or conferences are held for topics of special interest, but structured courses with certification in various topics beyond licensing generally are not offered.

The ARRL Certification and Continuing Education Program, approved by the ARRL Board of Directors in January 2000, is designed to fill that gap. During the first half of 2000, extensive discussions took place through the ARRL Members-only On-line Forum: **www.arrl.org/members-only/forums/w-agora.php3**. As discussions progressed, participants overwhelmingly supported emergency communications as the first course topic.

Volunteers from all over the country assisted in pulling together information for the course. Because the topic of emergency communications is so diversified and so much information is available, the material is broken into three levels: Introductory, Intermediate and Advanced Emergency Communications (Levels I, II and III). Each level is a separate course.

All ARRL C-CE courses are available on-line, thanks to ARRL's partnership with the Connecticut Distance Learning Consortium (CTDLC), a nonprofit organization that specializes in developing on-line courses for Connecticut colleges and universities. Continuing Education Units (CEUs) are available for all ARRL Certification and Continuing Education courses. For further information, refer to **www.arrl.org/cce.**

Each on-line course has been developed in segments — learning units with objectives, informative text, student activities, and quizzes. Courses are interactive and include direct communications with a Mentor/Instructor and other students. Mentors assist students by guiding them through the course. Students for each C-CE course are required to pass a Final Assessment (exam) of 25-multiple choice questions each with a score of 80% or better. All students who successfully complete the course requirements and pass the assessments earn an attractive certificate. Amateur Radio Emergency Communications Course (ARECC) Certification also includes an ID card.

In 2002, ARRL received a grant from the Corporation for National and Community Service (CNCS), an agency of the federal government, to fund the costs of the ARECC Level I course. Students still pay for the course when they register, but will be reimbursed after successful completion of the course. In 2003, ARRL received a grant from United Technologies Corporation (UTC) to expand the Amateur Radio Emergency Communications Course training to reimburse course tuition to students who successfully complete ARECC Levels I,

II, and III.

Practical on-the-air activities, such as ARRL's Field Day and Simulated Emergency Test offer additional training opportunities on a nationwide basis for individuals and groups. Participation in such events reveals weak areas where discussions and more training are needed. Also, drills and tests can be designed specifically to check dependability of emergency equipment or to rate training in the local area.

Field Day

The ARRL Field Day (FD) gets more amateurs out of their cozy shacks and into tents on hilltops than any other event. You may not be operating from a tent after a disaster but the training you will get from FD is invaluable.

In the ARRL Field Day, a premium is placed on sharp operating skills, adapting equipment that can meet challenges of emergency preparedness and flexible logistics. Amateurs assemble portable stations capable of long-range communications at almost any place and under varying conditions. Alternatives to commercial power in the form of generators, car batteries, windmills or solar power are used to power equipment to make as many contacts as possible. FD is held on the fourth full weekend of June, but enthusiasts get the most out of their training by keeping preparedness programs alive during the rest of the year.

Here are some links to find out more about the ARRL Amateur Radio Emergency Communications Courses.

- Frequently Asked Questions [**www.arrl.org/cce/faq.html**]
- CCE Course Syllabi [**www.arrl.org/cce/syllabus.html**]
- Registration for Online Courses [**https://www.arrl.org/forms/cce/**]
- Listing of Classroom Courses and Exams [**www.arrl.org/cce/activity-list.php3**]
- CI/CE Search Page [**www.arrl.org/cce/cice-search.php3**]
- Discussion Forum (Members Only) [**www.arrl.org/members-only/forums/w-agora.php3**]
- CCE Student Page (Members Only) [**www.arrl.org/members-only/cce/**]
- Course Listing [**www.arrl.org/cce/courses.html**]

Simulated Emergency Test

The ARRL Simulated Emergency Test (SET) builds emergency-communications character.

The purposes of SET are to:

- Help amateurs gain experience in communicating, using standard procedures under simulated emergency conditions, and to experiment with some new concepts.
- Determine strong points, capabilities and limitations in providing emergency communications to improve the response to a real emergency.
- Provide a demonstration, to served agencies and the public through the news media, of the value of Amateur Radio, particularly in time of need.

The goals of SET are to:

- Strengthen VHF-to-HF links at the local level, ensuring that ARES and NTS work in concert.
- Encourage greater use of digital modes for handling high-volume traffic and point-to-point welfare messages of the affected simulated-disaster area.
- Implement the Memoranda of Understanding between the ARRL, the users and cooperative agencies.
- Focus energies on ARES communications at the local level. Increase use and recognition of tactical communication on behalf of served agencies; using less amateur-to-amateur formal radiogram traffic.

Help promote the SET on nets and repeaters with announcements or bulletins, or at club meetings and publicize it in club newsletters. SET is conducted on the first full weekend of October. However, some groups have their SETs any time during the period of September 1 through November 30, especially if an alternate date coincides more favorably with a planned communications activity and provides greater publicity. Specific SET guidelines are announced in *QST*.

Drills and Tests

A drill or test that includes interest and practical value makes a group glad to participate because it seems worthy of their efforts. Formulate training around a simulated disaster such as a tornado or a vehicle accident. Elaborate on the situation to develop a realistic scenario or have the drill in conjunction with a local event. Many ARRL Section Emergency Coordinators (SECs) have developed training activities that are specifically designed for your state, section or local area. County Emergency Managers are often well practiced in setting up exercises that can help you sharpen your communications and general emergency reaction skills.

During a drill:

1) Announce the simulated emergency situation, activate the emergency net and dispatch mobiles to served agencies.
2) Originate messages and requests for supplies on behalf of served agencies by using tactical communications. (Don't forget to label each message with a "this

is a drill only" header, no matter what mode is used to transmit it.)

3) Use emergency-powered repeaters and employ digital modes.
4) As warranted by traffic loads, assign liaison stations to receive traffic on the local net and relay to your section net. Be sure there is a representative on each session of the section nets to receive traffic coming to your area.

After a drill:

1) Determine the results of the emergency communications.
2) Critique the drill.
3) Report your efforts, including any photos, clippings and other items of interest, to your SEC or ARRL HQ.

Net Operator Training

Network discipline and message-handling procedures are fundamental emergency preparedness concepts. Training should involve as many different operators as possible in Net Control Station and liaison functions; don't have the same operator performing the same functions repeatedly or you will lose valuable training experience for the other members of the group. There should be plenty of work for everyone. Good liaison and cooperation at all levels of NTS requires versatile operators who can operate either phone or CW. Even though phone operators may not feel comfortable on CW and vice versa, encourage net operators to gain familiarity on both modes by giving them proper training. They can learn by logging for a regular operator in that mode.

The liaison duties to serve between different NTS region net cycles as well as between section nets are examples of the need for versatile operators.

If no local traffic net exists, your club should consider initiating a net on an available 2-meter repeater, and coordinate these efforts with the trustee(s) of the repeater you'll use. Encourage club members to participate in traffic-handling activities, either from their home stations or as a group activity from a message center.

Ask your ARRL Section Emergency Coordinator, county Emergency Manager or Emergency Coordinator to conduct a seminar for your group on communicating with first responder personnel such as police, firefighters or emergency medical technicians. They use procedures that are different from those used in Amateur Radio. It is likely that your ARES and/or Radio Amateur Civil Emergency Service (RACES) group will need to communicate with them in real situations.

Appendix D

Methods of Handling Information

Emergency Operations Center

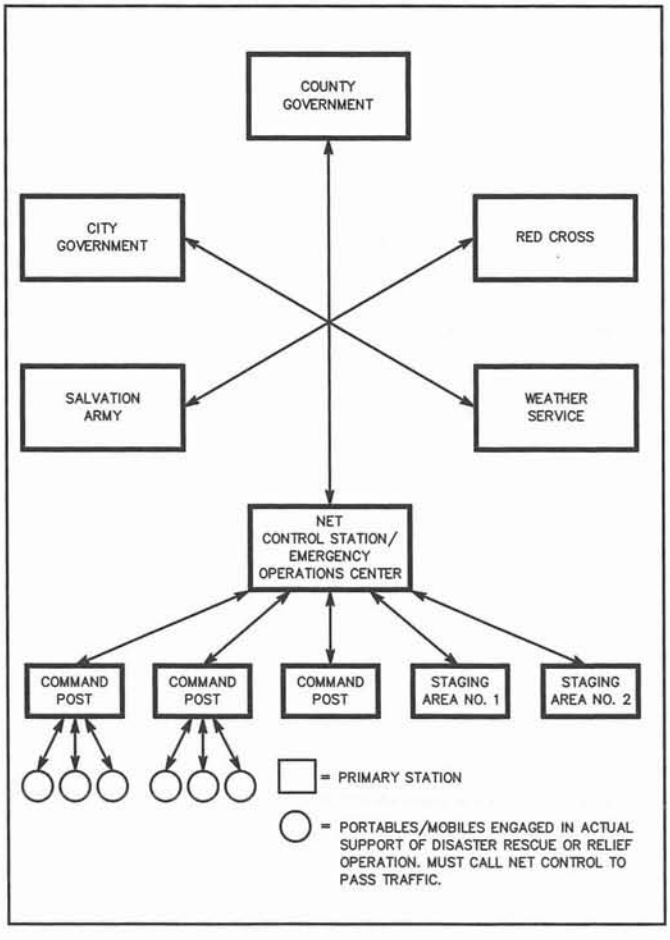
Amateur Radio emergency communications frequently use the Incident Command System (ICS). The ICS is a way to control initial and subsequent activities in emergency and disaster situations.

Consider an automobile accident where a citizen or an amateur, first on the scene, becomes a temporary Incident Commander (IC) when he or she calls for or radios for help. A law-enforcement officer is dispatched to the accident scene in a squad car and, upon arriving, takes over the IC tasks. Relief efforts, like those in this simple example of an automobile accident, begin when someone takes charge, makes a decision and directs the efforts of others.

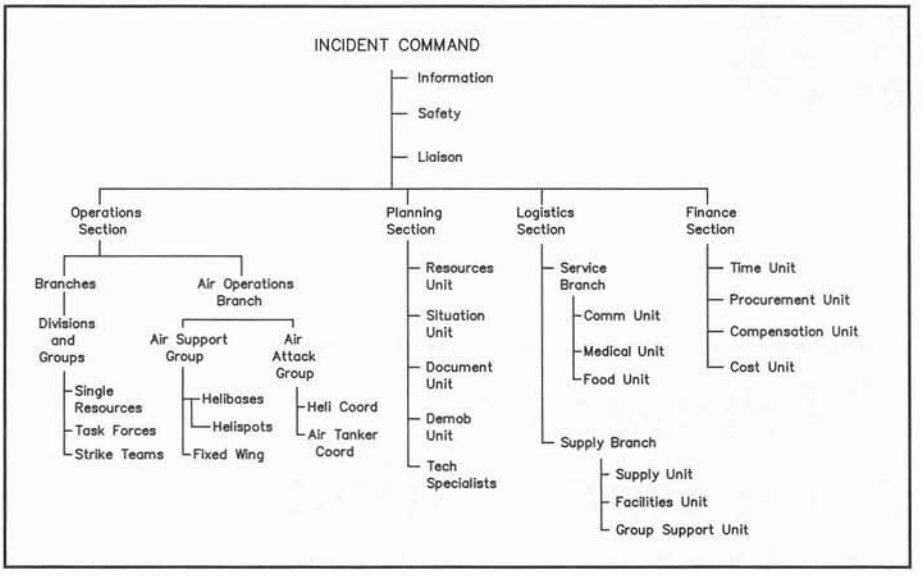
The Emergency Operations Center (EOC) responds to the IC by dispatching equipment and helpers, anticipating needs to supply support and assistance. It may send more equipment to a staging area to be stored where it can be available almost instantly or send more people to react quickly to changing situations.

If the status of an accident changes (a car hits a utility pole, which later causes a fire), the IC gives the EOC an updated report then keeps control even after the support agencies arrive and take over their specific responsibilities: Injuries—medical; fires—fire department; disabled vehicles—law enforcement or tow truck; and utility poles—utility company. By being outside the perimeter of dangerous activities, the EOC can use the proper type of radio communications, concentrate on gathering data from other agencies and then provide the right response.

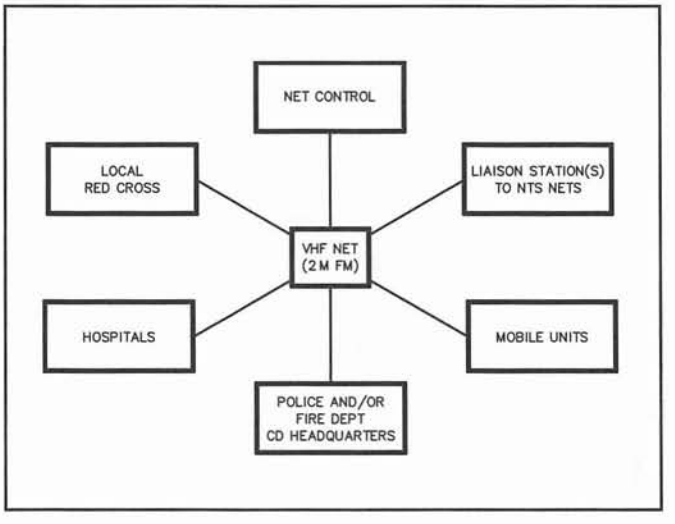
As an analogy, think of the ICs, who request action and provide information, being similar to net participants



The interaction between the EOC/NCS and the command post(s) in a local emergency.



The Incident Command System structure.



Typical station deployment for local ARES net coverage in an emergency.

checking into an amateur net with emergency or priority traffic. The EOC, who coordinates relief efforts, then functions as a Net Control Station.

Whether there is a minor vehicle accident or a major disaster operation, the effectiveness of the amateur effort in an emergency depends mainly on handling information.

Incident Command System

The Incident Command System (ICS) is a management tool that provides a coordinated system of command, communications, organization and accountability in managing emergency events and is rapidly being adopted by professional emergency responders throughout the country. Amateurs should become familiar with ICS to work with agencies in a variety of multiple jurisdictions and political boundaries.

Incident Command Systems use:

• ***Clear text and common terms***. Ten codes are avoided (though hams working with first responders should be familiar with them just in case). All ICS participants including hams are expected to be familiar with ICS terminology. When the Incident Commander orders "a strike team of Type 2 trucks," everyone affiliated with filling the order knows exactly what is being requested.

• ***Unified Command***. The Incident Commander is the only boss and is responsible for the overall operation.

• ***Flexibility***. Functions such as planning, logistics, operations, finance and working with the press are described in detail so the organization size can change to match the particular incident's requirements. The IC can consist of only a single individual for a small incident or it can expand to a Command Staff for a large incident.

• ***Concise Span of Control***. Since management works well with a small number of people, the ICS typically is designed so that throughout the system, no leader has more than about five people reporting to them.

In some areas the ICS evaluates and determines what resources will be needed to start recovery. Amateur communicators are typically within the Logistics Section, Service Branch and Communications Unit of an ICS.

Tactical Traffic

Whether traffic is tactical, by formal message, packet radio or amateur television, success depends on knowing which to use.

Tactical traffic is first-response communications in an emergency situation involving a few operators in a small area. It may be urgent instructions or inquiries such as "send an ambulance" or "who has the medical supplies?" Tactical traffic, even though unformatted and seldom written, is particularly important in localized communications when working with government and law-enforcement agencies. Note, however, that logs should be kept by hams passing tactical traffic. A log may be relevant later for law enforcement or other legal actions, and can even serve to protect the Amateur Radio operator in some situations.

The 146.52 MHz FM calling frequency—or VHF and UHF repeaters and net frequencies—are typically used for tactical communications. This is a natural choice because FM mobile, portable and fixed-station equipment is so plentiful and popular. However, the 222 and 440 MHz UHF bands provide the best communications from steel or concrete stuctures, have less interference and are more secure for sensitive transmissions.

One way to make tactical net operation clear is to use tactical call signs—words that describe a function, location or agency. Their use prevents confusing listeners or

agencies who are monitoring. When operators change shifts or locations, the set of tactical calls remains the same; that is, the tactical call remains with the position even if the operators switch. Amateurs may use tactical call signs like "parade headquarters," "finish line," "Red Cross," "Net Control" or "Weather Center" to promote efficiency and coordination in public service communication activities. However, amateurs must identify with their FCC-assigned call sign at the end of a transmission or series of transmissions and at intervals not to exceed 10 minutes.

Another tip is to use the 12-hour local-time system for time and dates when working with relief agencies, unless they understand the 24-hour or UTC systems.

Taking part in a tactical net as an ARES team member requires some discipline and following a few rules:

1) Report to the Net Control Station (NCS) as soon as you arrive at your assigned position.
2) Ask the NCS for permission before you use the frequency.
3) Use the frequency for traffic, not chit-chat.
4) Answer promptly when called by the NCS.
5) Use tactical call signs.
6) Follow the net protocol established by the NCS.
7) Always inform the NCS when you leave service, even for a short time.

In some relief activities, tactical nets become resource or command nets. A resource net is used for an event that goes beyond the boundaries of a single jurisdiction and when mutual aid is needed. A command net is used for communications between EOCs and ARES leaders. Yet with all the variety of nets, sometimes the act of simply putting the parties directly on the radio—instead of trying to interpret their words—is the best approach.

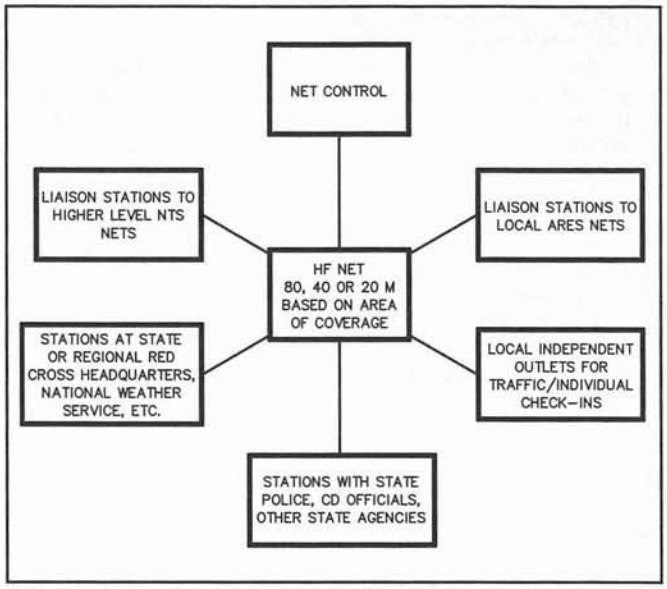
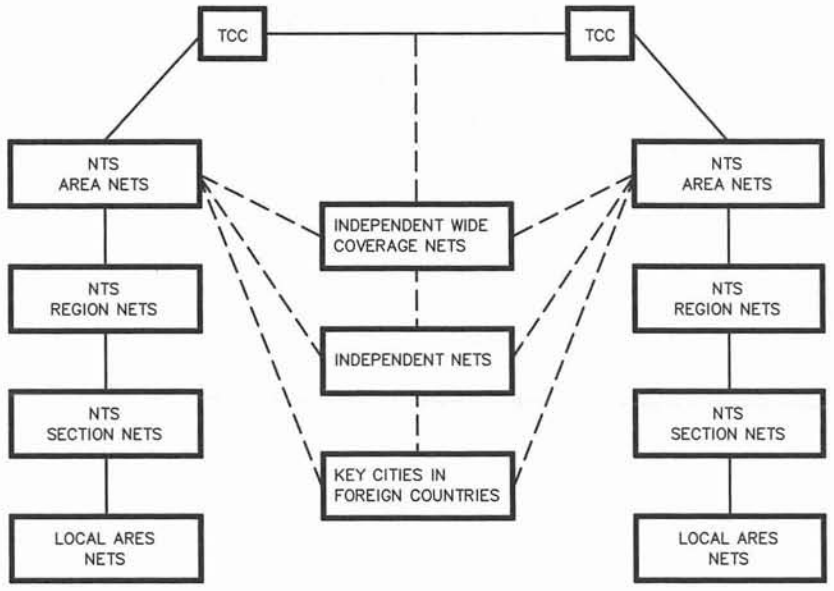


Fig 8-4—Typical structure of an HF network for emergency communications.

Formal Message Traffic

Formal message traffic is long-term communications that involve many people over a large area. It's generally cast in standard ARRL message format and handled on well established National Traffic System (NTS) nets, primarily on 75-meter SSB, 80-meter CW or 2-meter FM. [In addition, there is a regular liaison to the International Assistance and Traffic Net, IATN, now officially designated the NTS Atlantic Region Net (ARN). The net meets on 14.303 MHz daily at 1130 UTC (1100 during the summer), to provide international traffic outlets, as suggested in the figure below.

Formal messages can be used for severe weather and disaster reports. These radiograms, already familiar to many agency officials and to the public, avoid message



Emergency communications through liaison to NTS for handling formal message traffic.

Stress Management

Emergency responders should understand and practice stress management. A little stress helps you to perform your job with more enthusiasm and focus, but too much stress can drive you to exhaustion or death.

Watch for these physiological symptoms:

- Increased pulse, respiration or blood pressure
- Trouble breathing, increase in allergies, skin conditions or asthma
- Nausea, upset stomach or diarrhea
- Muffled hearing
- Headaches
- Increased perspiration, chills, cold hands or feet or clammy skin
- Feeling weakness, numbness or tingling in part of body
- Feeling uncoordinated
- Lump in throat
- Chest pains

Cognitive reactions may next occur in acute stress situations; many of these signs are difficult to self-diagnose.

- Short term memory loss
- Disorientation or mental confusion
- Difficulty naming objects or calculating
- Poor judgment or difficulty making decisions
- Lack of concentration and attention span
- Loss of logic or objectivity to solve problems

Perhaps the best thing to do as you start a shift is to find someone that you trust and ask them to let you know if you are acting a bit off. If at some time they tell you they've noticed you're having difficulty, then perhaps it's time to ask for some relief. Another idea is to have some sort of stress management training for your group before a disaster occurs.

duplication while ensuring accuracy. Messages should be read to the originators before sending them, since the originators are responsible for their content. When accuracy is more important than speed, getting the message on paper before it is transmitted is an inherent advantage of formal traffic.

Packet Radio

Packet radio is a powerful tool for traffic handling, especially with detailed or lengthy text (see Chapter 6) or messages that need to be more secure than those transmitted by voice. Prepare and edit messages off line as text files. These can then be sent error free in just seconds, an important timesaver for busy traffic channels. Public service agencies are impressed by fast and accurate printed messages. Packet radio stations can even be mobile or portable. Relaying might be supplemented by Winlink 2000, a system equipped to handle messages between HF and packet radio VHF stations.

Image Communications

Image communication offers live pictures of an area to allow, for example, damage assessment by authorities. Amateur Television (ATV) in its public service role usually employs portable Fast Scan Television (FSTV), which displays full motion, has excellent detail, can be in color and has a simultaneous sound channel. Although a picture is worth a thousand words, an ATV system requires more equipment, operating skill and preparation than using a simple hand-held radio.

Video cameras and 420-430 or 1240-1294 MHz radios can transmit public service images from a helicopter to a ground base station equipped with video monitors and a VCR for taping. Image communication works well on the ground, too. Video coverage of parades, severe weather, and even operation Santa Claus in hospitals adds another dimension to your ability to serve the public.

Slow Scan TV (SSTV) is also popular for damage assessment. Portable SSTV operations can use a digital still image camera, laptop computer and handheld or mobile transceiver. Signals may be relayed through a repeater to increase their range.

Automatic Packet Reporting System

APRS is an Amateur Radio technology that incorporates Global Positioning System (GPS) receiver tracking, Weather Instrumentation stations, digital cartography mapping, radio direction finding equipment and comprehensive messaging in one package. APRS has been adopted by some SKYWARN and ARES organizations as frontline technology for severe weather operations. Such a system provides accurate, real-time weather telemetry that SKYWARN operators and National Weather Service meteorologists use to issue severe weather warnings and advisories.

A combination of APRS and Emergency Management Weather Information Network (EMWIN) can be used to transmit warnings to field spotters to help track a storm's movement as well as report tornadoes or hail. A mobile APRS with GPS capability can be an essential tool during and following a large scale disaster to pinpoint critical locations in an area void of landmarks, such as forest fires or search and rescue activities. New APRS-friendly radios put tactical messaging capability in the palm of your hand.

Internet

The Internet provides a fluent, high speed conduit to communicate locally or over great distances. During nonemergency conditions, websites and e-mail are essential tools to help keep ECs in touch with many served agencies. Amateur Radio operators can contact their local organization or publicize emergency preparedness activites. Some Emergency Operation Centers have installed satellite-based Internet facilities with backup generator electricity.

Appendix E

Winlink2000

The Internet has become the message information medium of choice for most hams, but there is a sizeable group of amateurs who often travel beyond the reach of the Internet. This group includes hams at sea, travelers in recreational vehicles (RVs), missionaries, scientists, explorers and emergency management applications such as ARES and RACES. No doubt the day will come when wireless, affordable high-speed Internet access will be available from any point on the globe. Until that day arrives, however, the Winlink 2000 Amateur Radio digital network is the most capable existing media for Internet access, and it will do this worldwide. Winlink 2000 has been described as "what the worldwide packet radio networks wanted to be, but never attained."

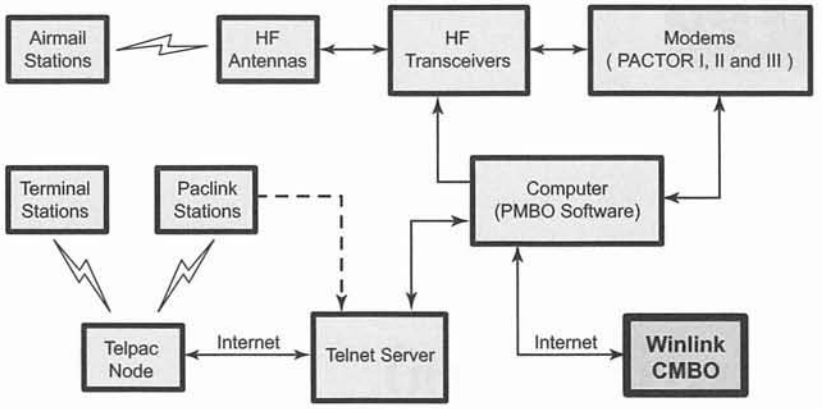
The Evolution of Winlink 2000

More than 40 HF digital stations worldwide have formed a remarkably efficient Internet information exchange network, including e-mail, binary file transfer and global graphic weather reporting and how-to bulletins. Running Winlink 2000 software and using the three PACTOR protocols, these facilities transfer information between HF stations and the Internet. They also share information among themselves using Internet forwarding.

In addition, most recently, over 150 VHF/UHF packet-to-Internet "Telpac" stations have joined the HF digital network stations, mostly for emergency preparedness purposes, to cover the "last mile" for their local regions.

The network evolved in the mid 1990s from the original AMTOR-based APLink system, authored by Victor D. Poor, W5SMM. APLink was a network of stations that relayed messages to and from each other and the VHF packet network (and Winlink 2000 still does this where VHF/UHF Packet exists.) As PCs became more

A world map of WinLink 2000 stations.



A simplified diagram of the WinLink 2000 system operation. The actual system may have 40+ HF PMBOs and 100+ Telpac VHF/UHF nodes. All forwarding between system participants is via internet TCP/IP or Telnet. For simplicity no user connections are shown.

powerful, and as the PACTOR protocols superceded AMTOR, a new software system was needed. That need brought about the debut of Winlink Classic, authored by Poor, with additions from Peter Schultz, TY1PS. Winlink itself evolved with substantial enhancements courtesy of Hans Kessler, N8PGR. To bring the Internet into the picture Winlink stations needed an e-mail agent to interface with cyberspace. To meet that requirement Steve Waterman, K4CX enlisted the help of Jim Jennings, W5EUT and Rick Muething, KN6KB, to add Netlink to Winlink Classic.

Winlink 2000 Today

Early in 2000, the system took a major technological and evolutionary leap, becoming a full-featured Internet-to-HF "star network" gateway system known as Winlink 2000 or "WL2K." Winlink 2000 is an International network of participating stations (PMBOs on HF and Telpac on VHF/UHF), all connected to a central server (CMBO), which is the hub for Internet connectivity to Internet e-mail, bulletins and position reporting.

Jim Corenman, KE6RK, concurrently developed software called *AirMail*, which is the end-user or "client" portion of Winlink 2000 on HF. On UHF/VHF, Winlink also hosts a Telpac module used with its end-user program, *Paclink*. These two modules are used together for short-range communication.

Thank to these advancements, as an example, HF digital operator at sea can now connect to a Winlink 2000 participating network station using *AirMail*, and exchange Internet e-mail with non-ham friends and family. He can also exchange messages with other amateurs by using the Winlink 2000 network stations as a traditional global mailbox operation. There are also over 700 NOAA and other text-based and graphic weather products available on request, which, of course, adds immeasurably to the safety and well being of the maritime ham. Likewise, with the use of Telpac and *Paclink*, local areas may be easily covered for emergency communications where the accuracy of written documents are necessary or desirable.

Most Winlink 2000 participating stations scan a variety of HF digital frequencies on a regular basis, listening on each frequency for about two seconds. By scanning through frequencies on several bands, the Winlink 2000 stations can be accessed on whichever band is available at any given time. At the time of this writing, 14 out of the existing 40 PMBOs use multiple radios in order to reduce the amount of scan cycle time for their stations, allowing multiple simultaneous connections resulting in a much greater throughput for the entire system.

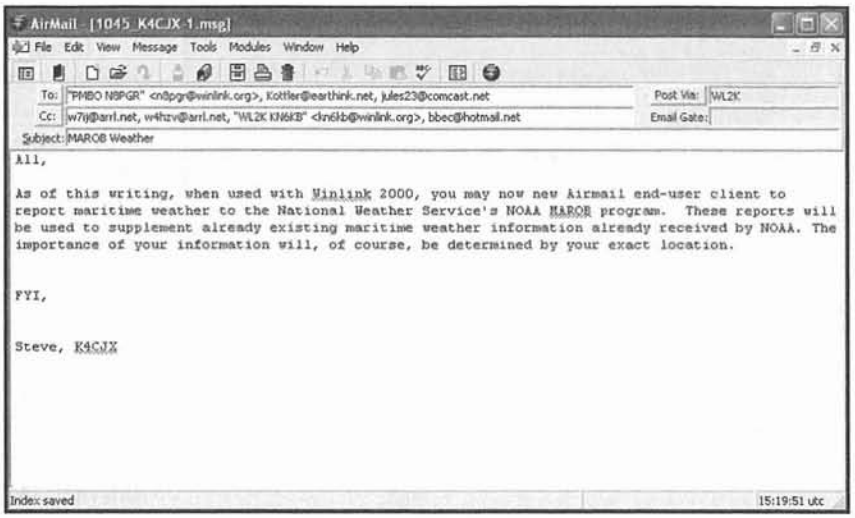
Reduction in Use of the HF Radio Spectrum

One important design objective of the Winlink development team was to reduce the use of the HF spectrum to only that required to exchange messages with a radio end-user, and to do that at full "machine" speeds. In many parts of the world, the HF spectrum is very crowded, especially on 20, 30 and 40 meters. By limiting the forwarding of messages between WL2K PMBOs through the Central Server (CMBO) to the Internet, a great deal of HF air time is eliminated making our valuable spectrum available to individual radio users either for message handling or for other operations. Efficient use of the Amateur Radio spectrum is paramount in the WL2K process as it should be in any Amateur radio application.

Elimination of the Need for a Home PMBO with the use of "Intelligent Routing"

Another important design objective of Winlink 2000 was to eliminate the traditional need to designate a specific "home" PMBO for an end- user (although he may optionally continue to such a designation). WL2K uses a message routing system the makes note of which Winlink PMBO stations a user has connected over a 90

day period. Whenever a message is received for a user, it is forwarded to these specific PMBOs. When the message is read at any one of these PMBOs, an internal notice is automatically sent to those specific PMBOs used by the particular user, indicating that the message was delivered, thereby, allowing it to be removed from any PMBO pending message list.



The *AirMail* message form.

Registering as a Winlink Radio User

When you first check into one of the PMBOs, your call sign will be accepted on a temporary basis until your license is automatically or manually verified for proper HF operation. If your call sign is from a country that does not have a publicly listed "official" database of Amateur Radio calls, then you will be asked to scan and e-mail or fax a copy of your license in order to remain a Winlink 2000 user. Otherwise, you will just be automatically instated within a short period of time. Alternatively, a user may ask any WL2K PMBO sysop to enter their call into the system database, and indicate the h-route of any MBO external to WL2K. If there is no record of a user's call in the system database then messages are forwarded to him based on the included h-route.

Message Delivery

For normal, non-emergency operations, users are automatically registered and their call signs verified simply by connecting to any WL2K PMBO. If a user checks into a PMBO for the first time, the system makes note of it and forwards all pending messages to that PMBO. The next time the user connects to that PMBO, any of his pending messages will be there. Messages will continue to come to all PMBOs that have registered the user. Should the user not check into a particular PMBO for 90 days, messages to the user will cease coming to that PMBO. This is of great benefit to mobile amateurs such as RVers, cruising vessels, and amateurs in remote locations that travel. It also keeps only those PMBOs that are relevant to the user active with that user's messages. There is no point in all PMBOs carrying messages for a user that only uses certain PMBOs.

A message sent from either another radio user or the Internet to a non-user will result in an automated message from the system stating that no such user is registered in the system. Users who do not check into the system for over six months are automatically purged from the system. Thereafter, they become a registered user again only when they once again check into the system.

Using *AirMail*

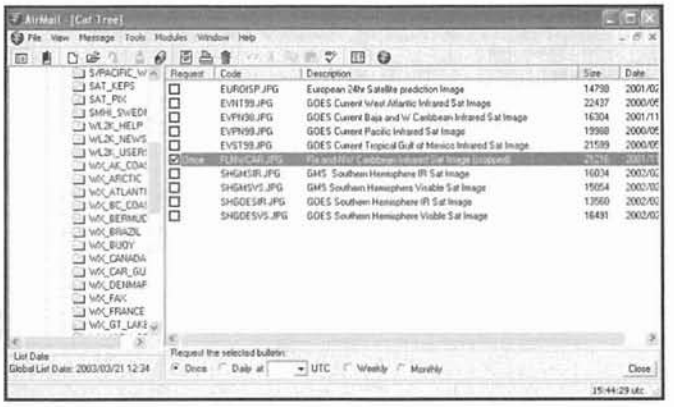
AirMail is one of the great strengths of the Winlink 2000 (WL2K) system. Just like any other e-mail application, by using a sophisticated program at the user's station, a much more friendly and error-free interface is provided to the user, and many more features and services are supported than with the traditional teleprinter-style keyboard interface. As with any Internet e-mail program, composing messages before going "on-line" also reduces the connect time on an HF connection where the spectrum is so valuable, allowing more users to access a given PMBO than is possible in keyboard mode. Also, advanced formats may be implemented easier with the use of this sophisticated client program, allowing the same messages to be compressed for shorter transmission times as well as providing the ability to add binary attachments such as, *Microsoft Word*, *Excel*, pictures or graphic weather files. Using *AirMail* instead of a keyboard mode not only allows messages to be written off-line so that the shortest, most efficient time is spent on the radio transferring data, but also speeds of up to 3600 bits per second permit transmissions which are hundreds of times faster than composing messages in real-time while on the air.

There is a limited terminal mode for interactive keyboard commands, allowing a terminal rather than computer-based software to connect to a PMBO. This method discouraged, and is only used for listing and deletion of messages.

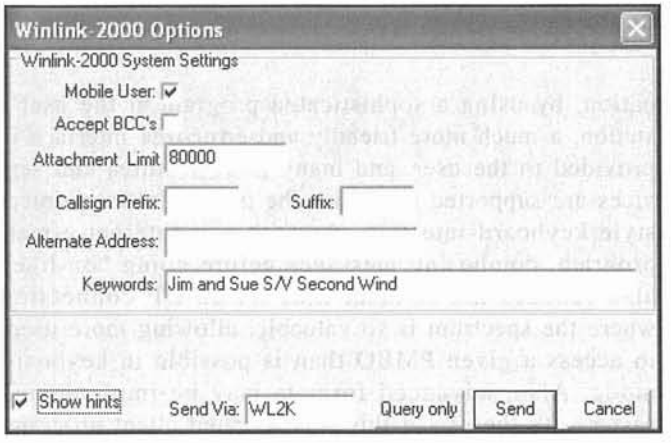
Today the end-user program of choice for HF radio is the *AirMail* client application written and supported by Jim Corenman, KE6RK. This is a very elegant user program that supports all of the features of WL2K and is provided for amateur use at no charge. It may be found on the Web at **www.airmail2000.com**.

Using *AirMail* to employ the many features of Winlink 2000

AirMail is intended to employ many of the features of the existing Amateur Radio digital networks, and to link the additional features of Winlink 2000 that are of particular value to amateur users who do not have access to the Internet



An *AirMail* catalog.



The Options message form.

With the *AirMail*'s end-user program, you can preset and control your radio if you configure it properly. Just choose a station, pick a frequency and push **SEND**. All information transfer is automatic and would be set up prior to the actual transmission just like any other e-mail agent. For the *AirMail* user, a continually updated list of PMBO stations and a built-in catalog update containing weather, as well as other helpful information, may both be requested via a radio download. Also, a continuously updated list may be found on the Web at **winlink.org/stations.htm** under "Winlink participating station (PMBO) center frequency list."

Remember that Winlink 2000 stations usually scan through several frequencies. If you can't connect, the Winlink 2000 station may already be busy with another user, or propagation conditions may not be favorable on the frequency you've chosen. Either try again later, or use the built-in propagation feature to connect on another band or to another Winlink participating station (PMBO). The number of frequencies scanned by the PMBO you are calling determines the length of your call. An FEC identification burst containing the called station and your call will be sent at the end of your transmission even if you do not successfully connect to a PMBO. This is a legal requirement for all Amateurs using the system, regardless of their country of origin.

In addition to *AirMail*, the VHF/UHF client program, *Paclink* employs Microsoft's *Outlook* or *Outlook Express* as well as Eudora's e-mail agents as an interface to the short-haul VHF/UHF packet module for Winlink 2000. When used with Telpac, a network node relay, which uses Telnet to reach a PMBO, *Paclink* can be a powerful communications tool for local and regional UHF/VHF communications. This will be discussed separately.

Transparent Interworking with Internet E-Mail

The primarily purpose of WL2K is to assist the mobile or remotely located user. Because of this, WL2K supports a clean seamless transparent interface to the Internet SMTP (Simple Message Internet Protocol) e-mail system. Any message may include any number of Internet addresses, and a WL2K radio user may be addressed simply with his call @winlink.org. The call, however, must be known to the system as a radio user or the message will be rejected. This SMTP aspect has an added benefit in case of an emergency where local services are interrupted, allowing anyone familiar with Internet e-mail the ability to use the system.

What does all this mean to you? From the Internet side of Winlink 2000, friends and family can send e-mail to you just as they would send e-mail to anyone else on the Internet. In fact, the idea of Winlink 2000 is to make HF e-mail exchanges look essentially the same as regular Internet e-mail from the user's point of view. Internet users simply address their messages to **<your call sign>@winlink.org**. For example, a message addressed to **k4cjx@winlink.org** will be available to me when I check into any Winlink 2000 station (PMBO), but only if I was already properly registered as a Winlink 2000. This is accomplished by simply logging into any Winlink 2000 participating station (PMBO). Thereafter, checking into other PMBOs will bring your mail to them for pickup, also.

Through the *AirMail* end-user "client" software, the ham user can address messages to anyone over the Internet using the above format, or to other hams for that matter, simply by addressing the ham call sign only (i.e.: wb8imy) or **call sign@winlink.org**.

Most messages are routed as a standard e-mail message. Multiple carbon copies (cc) or blind carbon copies (bcc) may also be received from the Internet. This feature may be turned off by the user in the *AirMail* "Options Message" menu, which provides other user definable options for the end-user. Messages handled by WL2K may have any number of addressees labeled either "To:" or "Cc:" and may mix any combination of radio and Internet SMTP style addresses.

Transparent File Attachments

Files of any type or number may be attached to a message by simply selecting the file to be sent from a *Windows* selection dialog in the user's *AirMail* program. Users receiving messages from WL2K may limit the size

of file attachments (down to zero) they are willing to receive. The PACTOR protocol chosen by the user usually should dictate the file size of an attachment.

Remember that the radio link is very slow (especially compared to the Internet). Normally, sending an attachment of more than 80,000 bytes is not a good idea. Text, RTF, DOC, XLS, JPG, BMP, GIF, WMO, GREB and TIF files are permitted as long as they are small enough to comply with the particular user-set limit. The Winlink 2000 "B2F" binary format compresses files when possible. For example, a text-based file is compressed about 44 percent; a JPG file is compressed very little while a 400,000-byte BMP file may be compressed to as little as 15,000 bytes.

Speed (and file size) depends on the PACTOR protocol used. For example, PACTOR I provides a maximum of 200 Bits per second, PACTOR II provides a maximum of 800 bits per second while PACTOR III provides a maximum of over 3600 bits per second. In the real world, this means that an 80,000-byte text file typically takes 80 minutes to transfer over PACTOR I, 20 minutes over PACTOR 2, but *only 5 minutes over PACTOR III.*

Sophisticated Bulletin Distribution

To address the needs of mobile users for near real-time data, WL2K uses an on-demand bulletin distribution mechanism. Users must first select requested bulletins from an available catalog managed in *AirMail*. When bulletin requests are received by a PMBO, a fresh locally cached copy of the requested bulletin is delivered. If no freshly local cached version is available, the PMBO accesses the Web and the bulletin is downloaded to the PMBO and then sent to the user. The catalog currently includes over 700 available weather, propagation, and information bulletins, including, instructions for using the system, world news and high-seas piracy reports. All WL2K PMBOs support a single global catalog, which insures user access to any bulletin from any PMBO. Bulletins can contain basic text, graphic fax or satellite images, binary or encoded files like GRIB or WMO weather reports. Local processing is used to reprocess images to sizes suitable for HF PACTOR transmission. The system prevents bulletin duplication and automatically purges obsolete time-sensitive weather bulletins and replaces them with the current version. WL2K also has the capability to accept limited packet BBS type bulletins received from other packet BBSs.

User Selectable Preferences

Using *AirMail*'s Options Message form, an individual user may send automatic service messages to any WL2K PMBO that will establish user-definable preferences system-wide. Such options include the size of acceptable file attachments, an alternate e-mail or radio address for temporary message forwarding, Bcc messages coming from Internet as well as other options. The user simply brings up the form, fills in the desirable user-definable options and then pushes **Send** on the Options Message form. The next time a user checks into any PMBO, these options will be sent to the Winlink 2000 system and applied to his call.

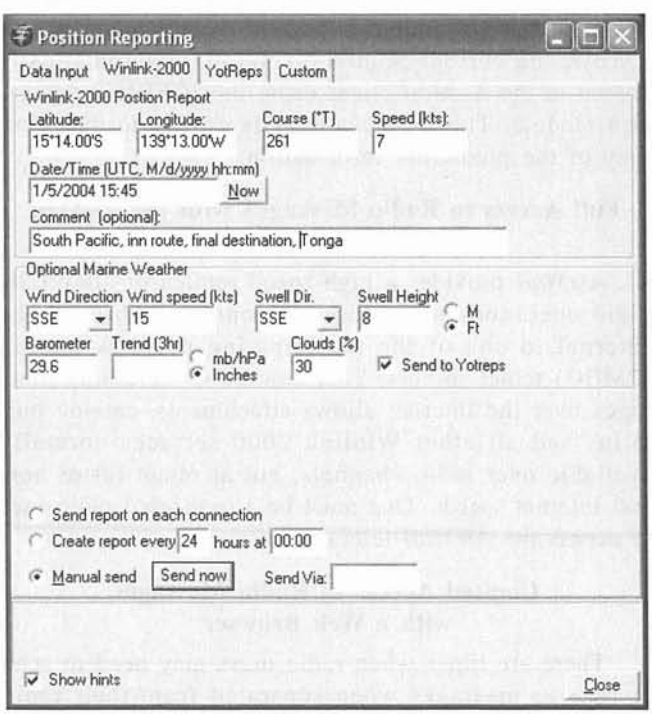
Position Reports and NOAA's NWS MAROB Reporting.

Another fascinating feature of Winlink 2000 is the ability to provide position reports for mobile users. Through the use of *AirMail*, they may be manually entered or sent electronically into *AirMail* from a handheld GPS through the GPS NMEA port. There are four ways in which a family member or friend may query position reports and determine where you are (or at least where you were at the last report). The three methods, obtain a graphic position report of a mobile user on a series of maps. These are the Automatic Position Reporting System (APRS), YotReps, or ShipTrak, a map tracking facility offered by the Maritime Mobile Service Net.

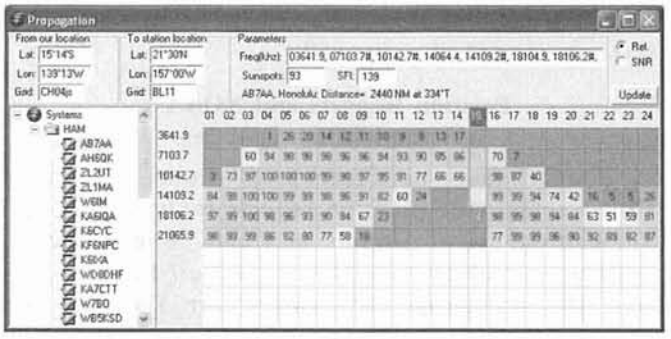
Simply go to the Winlink 2000 home page menu at **www.winlink.org** and click on **Position Reporter**. Enter the Winlink user's call sign and you are shown various views, depending on which service you choose. With APRS, in US territories, you may also see a satellite photo of the site!

The fourth method, which can provide historical tracking of up to 30 days, is to send an e-mail message addressed to **qth@winlink.org** requesting the report. The subject line of the message must be **Position Request**. The body of the message contains the call signs of interest (one call sign per line.) Once this request has been sent, a response with the requested information will be received as normal text e-mail.

The National Weather Service's NOAA MAROB weather reporting facility has is also contained on the *AirMail* client software position reporting form for mari-



An AirMail position Reporting/NWS NOAA MAROB form.



An *AirMail* Propagation form.

time users. This facility provides an opportunity for maritime users to report maritime weather conditions to NOAA. A special weather category is being employed which will contain all such valid reports in an attempt to fill in the blanks where other weather reporting is weak or non-existent. More about MAROB weather may be obtained on the Web at **www.nws.noaa.gov/om/marine/marob.htm**.

The position and weather reporting capabilities within Winlink 2000 aides immeasurably to the safety and well-being of those using the Winlink 2000 system as well as for those who are concerned about their family and friends who are Winlink 2000 users.

Propagation Assistance

AirMail uses the *ICEPAC* propagation program as a prediction engine. In order to use *AirMail*'s propagation window, I*CEPAC* must be downloaded and installed into its own default directory. Once installed, the program works as a part of *AirMail* to provide accurate propagation information to assist the Winlink 2000 user in determining which participating stations (PMBOs) are available for connection. Each time a user connects to a PMBO, the current Solar Flux Index is automatically passed to the *AirMail* client using the *ICEPAC* propagation module. This, of course, adds greatly to the accuracy of the prediction information.

Full Access to Radio MessageS with the *AirMail* Telnet Feature

AirMail provides a high-speed replica of all WL2K radio operations while directly connected through the Internet to one of the participating network station (PMBO) telnet servers. This method of obtaining messages over the Internet allows attachments, catalog bulletins and all other Winlink 2000 services normally available over radio channels, but at much faster normal Internet speeds. One must be a registered radio user to access the *AirMail* telnet feature.

Limited Access to Radio Messages with a Web Browser

There are times when radio users may need to send or receive messages when separated from their radio access or *AirMail* system. This may be done with password protected Web access from any Web browser. Messages sent and received by this method are limited to text-based messages and without the use of bulletins or file attachments. In order to use this service, a user must have logged in over radio within the last 6 months. Again, to become a registered and legally verified radio user, all one must do is log in over the air to one of the existing PMBOs at least every 6 months.

System Wide User Notices

The WL2K network administrator may post system wide notices that are delivered to all individual WL2K users as a private message. This is a valuable tool for notifying users of system enhancements, outages, software upgrades or emergencies.

Support for an Optimal Number of Participating Winlink PMBOs

The WL2K system will support an optimal number of individual participating PMBOs in order to cover the global traffic volumes. Requirements for becoming a PMBO may be obtained by contacting the WL2K system administrator, K4CJX, at **k4cjx@comcast.net**. For those who are not interested in becoming a full-time PMBO, the VHF/UHF Telpac option may be in order. Telpac information and download may be found on the Web at **www.winlink.org/features.htm**.

User Time Limits

To ensure equitable access to the system individual users are assigned daily time limits on HF frequencies by PMBO sysops. The default time per any 24 hour period is 30 minutes, however, the user may request more time from the PMBO sysop should it be needed. Remember, the time limit is individual to each PMBO station. Utilization of the PACTOR II and PACTOR III protocols are a great timesaver, allowing the user up to 18 times the volume of messages over that of PACTOR I for the same period of time.

Other Features

The system has a number of other secondary features to help keep it healthy. Extensive traffic reports are collected, the state of individual PMBO and the CMBO are monitored (**winlink.org/status**), and daily backups are performed automatically at all PMBOs as well as the two redundant Central Servers (CMBO) to insure the system integrity. Security is insured through the vigorous updating of virus definitions and automatic virus screening for all Internet mail and files. The system has the ability to block any user by both radio (by frequency band) and Internet (by e-mail address) to prevent abuse of the system. Spam is controlled using several services that control spam e-mail.

User Driven System

The Winlink 2000 system was developed from a long list of user requirements. With obvious focus on the individual user groups, the Winlink development team continually seeks feature ideas and system concepts from

the user community it serves. If you are interested in digital radio, there is a place for you and your ideas with Winlink 2000.

As a result of providing the Amateur Radio community with an ever-expanding system, the Winlink development team has enhanced the ability of Winlink 2000 to deal with emergency communications. Much information regarding this subject may be found on the Winlink 2000 Web site at **winlink.org/emergency.htm**.

The Winlink 2000 VHF/UHF Telpac Module for Expanded Local Packet Radio Access

Mainly designed to satisfy the requirements and requests of the Amateur ARES/RACES community, the Winlink development team has added two new modules to its client (user based) applications for delivering mail from the Winlink 2000 system to the wireless ham user. "Telpac" stands for TELnet PACket Bridge. Telpac is optimized to easily interface Winlink 2000 to conventional VHF/UHF Packet users and BBSs. This includes simple portable terminals (e.g. Palm devices), as well as more capable FBB compatible programs including *AirMail* packet.

Telpac efficiently links conventional amateur AX.25 packet to Winlink 2000 's Telnet Servers and uses the *AGW Packet Engine*, which supports virtually all Packet TNCs (including BayCom and sound cards). TNCs can be remote and shared with other *AGW Packet Engine* applications. Telpac is simple to set up and run and requires a minimum of computer and radio equipment. The Telpac software runs independently from the more complex Winlink 2000 Network PMBO software. Telpac is ideal for a temporary emergency management setup or any other unattended remote location where it can deliver reliable wireless communication to the last mile.

Telpac takes VHF/UHF AX.25 packet, adds the ability to add binary attachments with the B2F protocol and automatically links with the Winlink 2000 network via Telnet to a participating Winlink network station (PMBO.) As of this writing, future plans include using HF linking as an emergency alternative to the existing telnet link.

Paclink is the client (user) based module that talks to the Telpac node. It employs *Microsoft's Outlook* or *Outlook Express* and operates seamlessly in an Internal LAN network as just another mail server. *Paclink* employs the *AGW Packet Engine* for ease of use with just about any generation of packet TNC or even a sound card. *Paclink* also has a telnet option to VHF/UHF packet. *Paclink* is a relatively small program and will operate on *Windows 2000 Professional, XP Home* or *Pro* editions. *Paclink* uses the new Microsoft .NET framework.

More about Telpac and *Paclink* may be found at **www.winlink.org/Client.htm# - Te-Pac**.

The Future of Winlink 2000

In today's hamming environment, digital message transfer is relatively new, but growing rapidly. It has many uses that are relevant to our hobby. First of all, it shows those who are skeptical about the ability of the ham community that we are still on the cutting edge of technology. Secondly, it is helping to boost services such as Emergency Management (**winlink.org/emergency.htm**). As long as Winlink 2000 continues to embrace enabling technologies, it will continue to grow and attract those who have an interest in computing, radio, Emergency Management and other similar disciplines. The amateur priorities of the past are not necessarily those of the future, and those developing the feature sets and structure of Winlink 2000 are aware that of these facts.

As of this writing, the Winlink development team is planning for Winlink 2004 that will expand the service it employs to an even greater audience of Amateur radio users. A prime example of this is the inclusion of Telpac and *Paclink* into the existing structure.

How To Get Involved

If you have an interest in Winlink 2000, you may wish to periodically review the Winlink Web site, **www.winlink.org**, for further developments as it simplifies the requirements for a participating on many levels. In summary, those involved with the development of this technology welcome newcomers with open arms. It may just a fun and desirably effective tool for your own use. You never know until you investigate its many uses.

Index

W

FEEDBACK

Please use this form to give us your comments on this book and what you'd like to see in future editions, or e-mail us at **pubsfdbk@arrl.org** (publications feedback). If you use e-mail, please include your name, call, e-mail address and the book title, edition and printing in the body of your message. Also indicate whether or not you are an ARRL member.

Where did you purchase this book?

☐ From ARRL directly ☐ From an ARRL dealer

Is there a dealer who carries ARRL publications within:

☐ 5 miles ☐ 15 miles ☐ 30 miles of your location? ☐ Not sure.

License class:

☐ Novice ☐ Technician ☐ Technician Plus ☐ General ☐ Advanced ☐ Amateur Extra

---

Name _____ ARRL member? ☐ Yes ☐ No

_____ Call Sign _____

Daytime Phone ( ) _____ Age _____

Address _____

City, State/Province, ZIP/Postal Code _____ E-mail: _____

If licensed, how long? _____

Other hobbies _____

_____

Occupation _____

For ARRL use only	EmCommHbk
Edition	1 2 3 4 5 6 7 8 9 10 11 12
Printing	2 3 4 5 6 7 8 9 10 11 12

From _____

_____

_____

Please affix postage. Post Office will not deliver without postage.

EDITOR, EMERGENCY COMMUNICATION HANDBOOK
ARRL—THE NATIONAL ASSOCIATION FOR AMATEUR RADIO
225 MAIN STREET
NEWINGTON CT 06111-1494

please fold and tape